S

1956

THE CANADIAN ASSOCIATION OF GEOGRAPHERS

THE CANADIAN GEOGRAPHER

LE GÉOGRAPHE CANADIEN

L'ASSOCIATION CANADIENNE DES GÉOGRAPHES

CANADA

THE CANADIAN ASSOCIATION OF GEOGRAPHERS
L'ASSOCIATION CANADIENNE DES GEÓGRAPHES

The objectives of the Association are to promote the study of, and research in geography. Full Membership, for which the annual dues are $10, is open to any professional geographer. Full-time university undergraduate students may become Student Members for $3 per annum. The annual dues for Associate Membership, which is open to any other person interested in the objectives of the Association, is $5.

Officers of the Association, 1955-56
Officiers de l'Association, 1955-56

Honorary Presidents – *Présidents Honoraires*
GRIFFITH TAYLOR   RAOUL BLANCHARD

President – *Président*
J. LEWIS ROBINSON

Vice-President – *Vice-Président*
TREVOR LLOYD   PIERRE CAMU

Councillors – *Conseillers*

W. G. DEAN	D. Q. INNIS	D. P. KERR
N. L. NICHOLSON	R. T. RUGGLES	W. C. WONDERS

Secretary *Secrétaire*	Assistant Secretary-Treasurer *Assistant Secrétaire-Trésorier*	Treasurer *Trésorier*
MARION MATHESON	RONA DRINNAN	M. R. DOBSON

Box 421, Ottawa, Ontario

Editor, The Canadian Geographer – *Editeur, Le Géographe Canadien*
N. L. NICHOLSON
Manotick, Ontario

HT

Le but de l'Association est de promouvoir l'étude et la recherche en géographie. Tout géographe professionnel, moyennant une contribution annuelle de $10, peut devenir membre actif de l'Association. Pour la somme de $3 par année tout étudiant inscrit comme sous-gradué en géographie dans une université, peut devenir membre-étudiant. Enfin peut devenir membre-associé de l'Association pour la somme de $5 par année, toute personne qui s'intéresse aux objectifs de l'Association.

THE CANADIAN GEOGRAPHER   LE GEOGRAPHE CANADIEN

No. 7   1956

CONTENTS ---------- TABLE DES MATIERES

Published by

THE CANADIAN ASSOCIATION
OF GEOGRAPHERS

Publié par

L'ASSOCIATION CANADIENNE
DES GEOGRAPHES

Price $1.00

MACKENZIE DELTAS - A PROGRESS REPORT [1]

J. Ross Mackay

University of British Columbia

The Mackenzie River is the descendant of one or more older rivers that flowed into the Beaufort Sea during interglacial ages of the Pleistocene epoch. The old rivers can be recognized by remnants of their channels and deltaic deposits. In the few thousand years since the Mackenzie Delta area has become free of glacier ice, there have been major changes in the land-sea relationships which have introduced complexities into the history of the modern delta. In this paper, a progress report is given on old and recent deltaic deposits and channels in the Mackenzie Delta area.

Modern Mackenzie Delta

The modern Mackenzie Delta (Figure 1) has partially filled in the trough between the Richardson Mountains on the west and the Caribou Hills and Richards Island on the east, so it is of the estuarine type. Although the trough may be structurally controlled, it is a river-eroded and glacier-modified valley. The modern Mackenzie Delta is a physiographic unit of distinctive characteristics which separate it from older deltaic deposits.[2] The delta sediments are fine grained. Coarse sand is scarce and a pebble is a rarity. Fine sand, silt, and clay with organic matter of varying abundance, comprise the material of the modern delta.[3]

Although thousands of shallow lakes and hundreds of miles of winding channels seemingly stamp the delta with a monotonous uniformity, broken only by vegetation changes, nevertheless there are significant variations in the number, size, shape and depth of lakes; in the heights of stream banks above sea-level; and in the patterns of the channels.

---

[1] Based upon field investigations carried out for the Geographical Branch, Department of Mines and Technical Surveys, Ottawa, with whose permission this paper is published. It is a pleasure to acknowledge the contributions made by John K. Stager and Victor W. Sim. They assisted in the field and also in a statistical study of the lakes of the Mackenzie Delta area.

[2] Taylor, Griffith: "Arctic Survey, Part III. A Mackenzie Domesday: 1944", Canadian Journal of Economics and Political Science, II, No. 2, May 1945, pp. 189-233. Taylor was one of the first to stress the physiographic differences between the modern Mackenzie Delta and the region to the east.

[3] Leahy, A.: "Characteristics of soils adjacent to the Mackenzie River in the Northwest Territories of Canada", American Soil Science, Proceedings, 12, 1947, pp. 458-461; J.A. Philainen and G.H. Johnston, Permafrost Investigations at Aklavik: 1953, Division of Building Research, National Research Council, Ottawa, Technical Paper No. 1, January 1954, pp. 11-15.


132°
136°
135°
134°
133°
132°
PULLEN IS.
HOOPER IS.
PELLY IS.
GARRY IS.
MACKENZIE BAY
KUGMALIT BAY
RICHARDS ISLAND
MACKENZIE RIVER
TUKTOYAKTUK
KITTIGAZUIT
ESKIMO LAKES
69°
TUNUNUK
CARIBOU HILLS
REINDEER STN.
MOOSE CH.
WEST CH.
SITIDGI LAKE
RICHARDSON MOUNTAINS
AKLAVIK
CAMPBELL LAKE
68°
MODERN DELTA
OLD DELTAS
0 10 20
MILES
EAST CH.
RAT R.
PEEL R.
PT. SEPARATION
136°
135°
134°
133°

Figure I.

The number of lakes per square mile is shown in Figure 2 and the per cent of the total area in lakes in Figure 3.[1] The two maps show a very interesting relationship. The highest and lowest concentrations of lakes per square mile correlate well with the per cent of the area in lakes. The middle delta has the greatest number (7 to 10) of lakes per square mile and the highest (30 to 50) per cent of the area in lakes. The pattern in the upper delta is more confused, owing partly to sedimentation from the Peel and Rat Rivers, but in general the number of lakes per square mile and the area in lakes is less than in the middle delta. The seaward fringe of the delta has few lakes and a small per cent of the area in lakes. Since the northward decrease in the number of lakes per square mile is more rapid than the corresponding per cent decrease in total lake area, the sizes of the lakes must increase from south to north. The general relationships between total lake number, and individual lake size are shown in graphs of Figure 4. The three graphs represent averaged conditions in a 15-mile wide south-north band from $67^\circ 30'$ N. latitude, just south of the delta and a few miles east of Peel River, to $69^\circ 30'$ N. latitude, on the outer delta just west of Richards Island. The curves have been smoothed in order to depict the overall trends.

The low outer or seaward flats of the delta have the fewest lakes and the lowest per cent of the area in lakes but the largest lakes in the delta. As the delta is gradually extended seaward and the flats are built higher, the per cent of lake cover increases at the expense of a reduction in the sizes of the large lakes. The reduction in size is due to the infilling by sediment and destruction by shifting channels rather than to vegetation growth. In view of the high ice content of the delta sediments, the formation of ice segregations - lenses, veins, wedges, layers - adds materially in building up the delta level and in the formation of lakes.

The cut banks of the Mackenzie River and its delta channels often have a slight overhang, draped like a curtain, where the soil is bonded with roots. The heights of the banks cannot be measured accurately at present because there is no datum from which altitudes can be measured. As a general impression, the decrease in bank heights seems to be more rapid north of Reindeer Station than south of it. The slipoff slopes vary considerably and may be straight, concave, convex, step-like, or a combination of several types.

Trout and Campbell (also known as Gull) Rivers, which connect Trout and Campbell Lakes with the East Channel of the Mackenzie River, are excellent examples of reversing rivers. Their channels lack well-defined undercut and slipoff banks. The channel banks in cross-section are symmetrical with uniform rather than asymmetrical slopes. The general absence of undercut and slipoff slopes is due to the reversing flow which carries Mackenzie River floodwaters into the storage basins of the lakes to build deltas into them and then returns the water, when the level of the Mackenzie River falls, into the East Channel. A fluctuation of a few inches in the height of the water of the East Channel is sufficient to reverse the flow.

Old Mackenzie Deltas

Most of Richards, Garry, Pelly, Hooper and Pullen Islands, Tuk Peninsula (here used for the area north and northeast of the Caribou Hills), a coastal fringe

---

[1] The statistical data was obtained by using the traverse sampling method on the Preliminary Map of the Mackenzie River Delta, 1951, scale 3 miles to the inch. The map is minutely detailed as it was compiled from aerial photographs. The lake intercepts were measured for every 10 minutes along the meridians and parallels, a total of some 400 values being used in plotting the maps. Figures 2 and 3 are good approximations to actual conditions, but more detailed maps are being prepared from aerial photographs by John K. Stager.

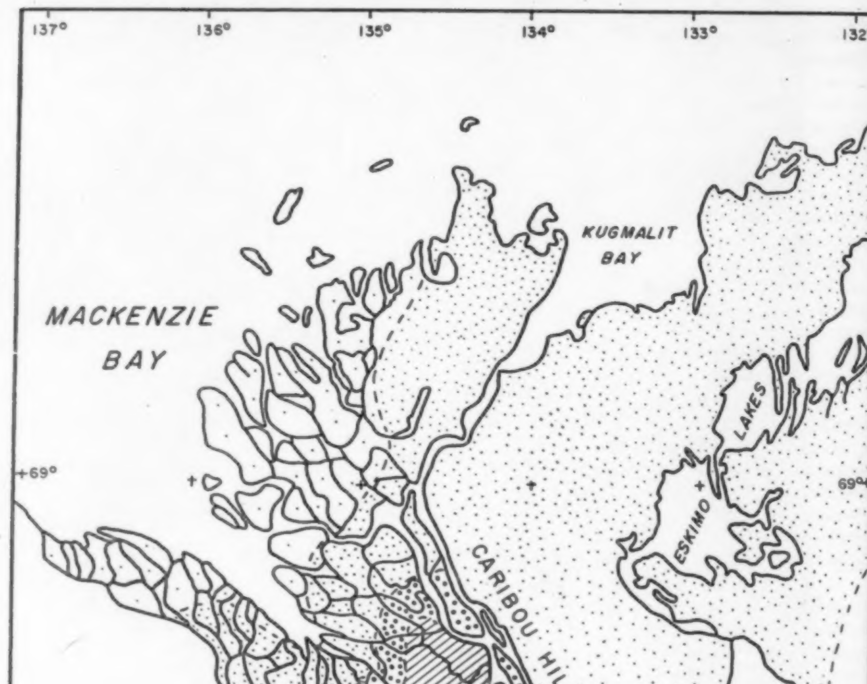

137°
136°
135°
134°
133°
132°
KUGMALIT
BAY
MACKENZIE
BAY
69°
LAKES
ESKIMO
CARIBOU HILLS
RICHARDSON MOUNTAINS
NUMBER OF LAKES
PER SQUARE MILE
0 - 1
1 - 4
4 - 7
7 - 10
OVER 10
68°
0 10 20 MILES

Figure 2.

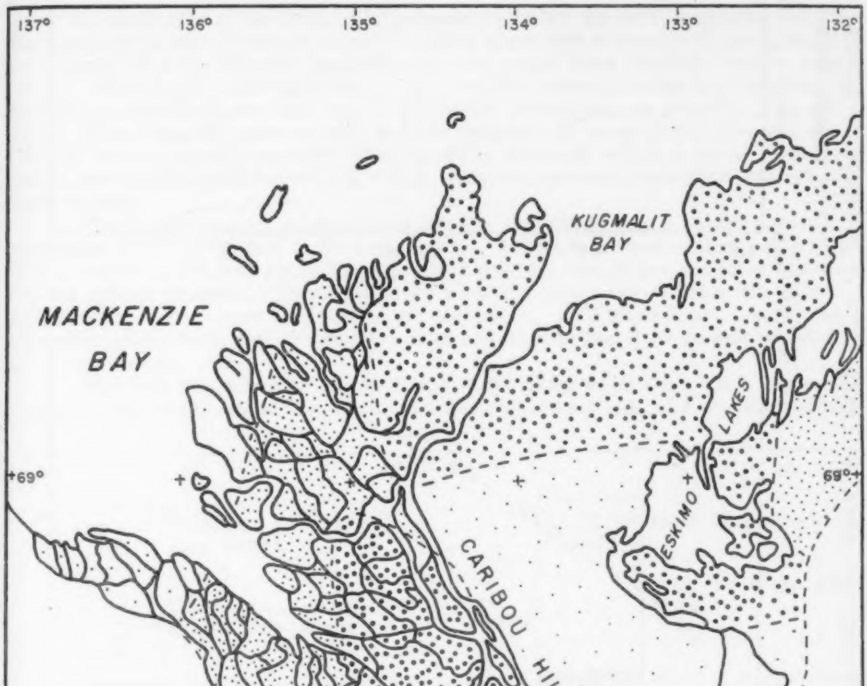

137°
136°
135°
134°
133°
132°
KUGMALIT BAY
MACKENZIE BAY
LAKES
ESKIMO
69°
CARIBOU HILLS
RICHARDSON MOUNTAINS
68°
PERCENT OF AREA IN LAKES
10 - 20
20 - 30
30 - 50
0 10 20 MILES

Figure 3.

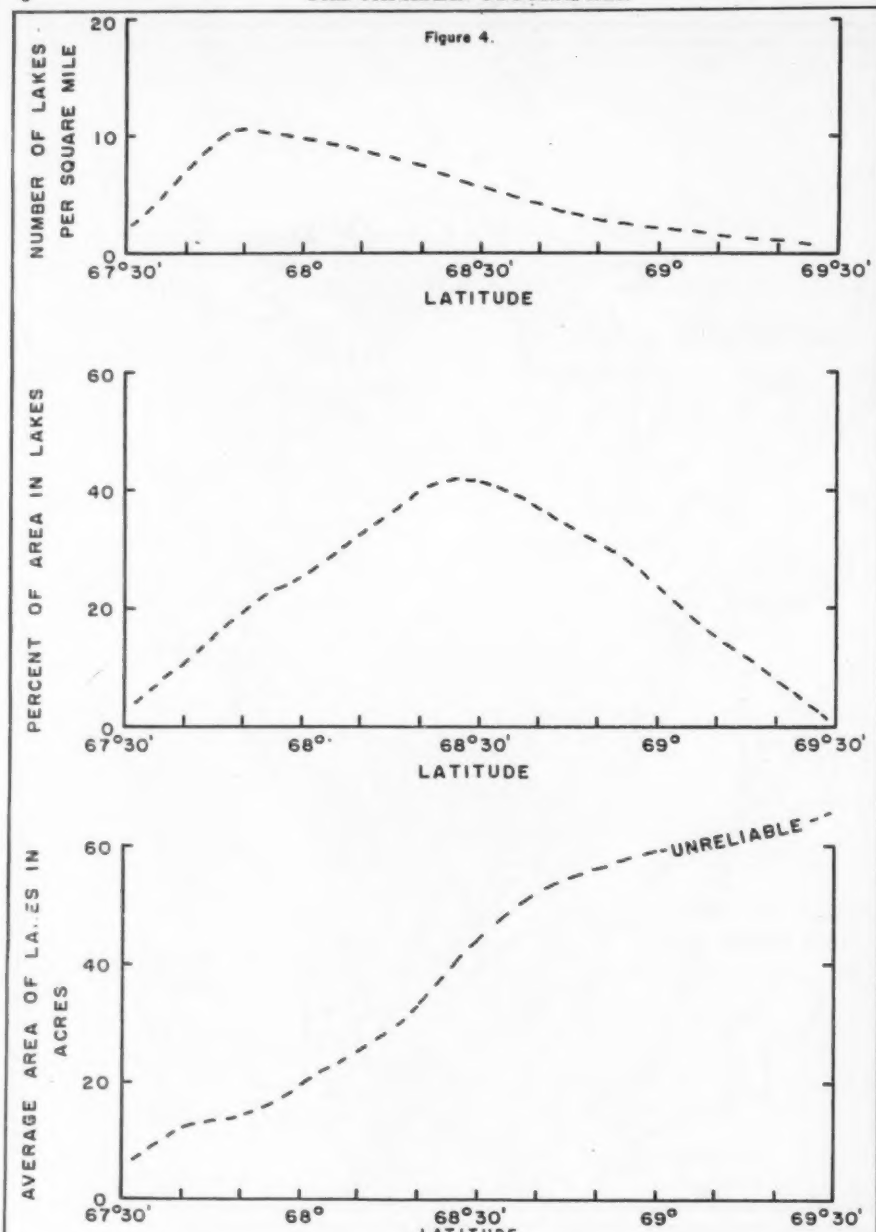

NUMBER OF LAKES PER SQUARE MILE
0
10
20
67°30'
68°
68°30'
69°
69°30'
LATITUDE
PERCENT OF AREA IN LAKES
0
20
40
60
67°30'
68°
68°30'
69°
69°30'
LATITUDE
AVERAGE AREA OF LAKES IN ACRES
0
20
40
60
UNRELIABLE
67°30'
68°
68°30'
69°
69°30'
LATITUDE

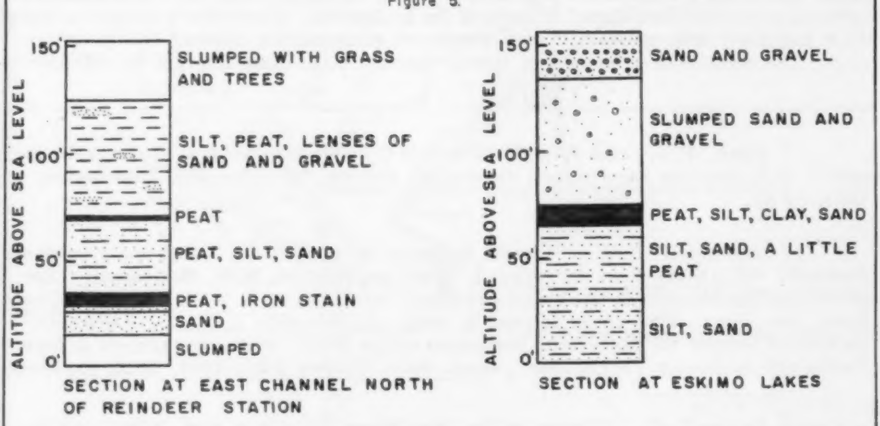
Figure 4.

along the south side of the Eskimo Lakes, and probably the Baillie Islands and Cape Bathurst, form part of one or more old deltas along with a veneer of post-glacial sediments. For convenience in discussion, the plural form "deltas" will be used for the old deposits, although there is no proof that several deltas are involved; in addition, some of the deposits may be fluviatile, lacustrine, or marine. The old deltas differ from the modern delta in their terrain, for parts are at a higher altitude and have a greater relative relief; in their material, which is usually coarser; and in their geomorphic history, for they are older and have been glaciated, at least in part.

The old deltas are mostly below 200 feet in altitude with a relative relief commonly less than 75 feet to the square mile. Although the summits of a few pingos rise as much as 150 feet above the old delta surfaces, the pingos are later features and not deltaic deposits. The Caribou Hills and the land a few miles south of the Eskimo Lakes rise above the level of the old deltas. As Figure 2 and 3 show, the old deltas differ from both the modern delta and the Caribou Hills in their number and size of lakes.

The best exposures of the old deltas occur along wave-cut cliffs. Figure 5 shows two sections, one at 68° $52'$ N. latitude on the east side of East Channel and

Figure 5.



the other at 68° $46'$ N. latitude and 133° $15'$ W. longitude at the southern end of the Eskimo Lakes, the sections being 25 miles apart. The two sections are very similar in their lithology, stratigraphic sequence, and altitude. The intercalation of peat, silt, sand, and gravel is a succession that probably represents river or delta deposits. The peaty layers, the logs and water-worn driftwood - pieces of which may be partly or completely carbonized - resemble the deposits found along present cut banks of the Mackenzie River. No plants in the peaty layers were found growing in situ with roots penetrating into a soil horizon below. Neither were any indications seen to suggest the former presence of vertical ice wedges, such as occur in the modern delta and old periglacial regions. Most of the northern portion of Tuk Peninsula from Tununuk on the west to Cape Dalhousie on the east is low and sandy with very few stones. The two Baillie Islands and the Cape Bathurst area are composed largely of frozen muds with tabular sheets of ground ice, the muds being overlain by

northwest-southeast trending low ridges of ice-free silt loam.

The old deltaic material of Richards Island and that north of the Caribou Hills is probably interglacial, because an esker overlies the formation at the southern end of Richards Island. As the extent of glaciation is unknown, it is impossible to determine the distribution of the old deposits. In view of the fact that multiple glaciations have been recognized in nearby areas of Alaska,[1] it would be surprising if they were absent in the Mackenzie Valley. Boulder clays separated by gravels, possibly of interglacial age, have been observed in the lower Mackenzie Valley and nearby areas.[2] Glacial deposits have been observed up to an altitude of 3,000 feet at Mount Goodenough near the apex of the delta and probably occur along the Arctic Coastal Plain towards Herschel Island.[3]

Although erratics are common along some beaches, for example near Tuktoyaktuk, the extensive sandy bluffs of the old deltaic deposits do not appear to be overlain by till unless it is very thin, fine grained, and almost completely stone-free. Nevertheless, morainic topography does occur inland, such as a few miles south of Tuktoyaktuk. It has been suggested that Tuk Peninsula is a gigantic end moraine,[4] although this is debatable.

Nicholson Island, at the southern end of Liverpool Bay, rises to 295 feet, a height greatly exceeding that of the other old deposits. The frozen muds, silts, and sands have been overthrust to the east, probably by glacier ice, the overthrusting accounting for the exceptional altitude of the sediments. There are a number of drag folds and many fault slices with well developed slickensides showing in the frozen clay. The sediments of Nicholson Island, therefore, predate the last ice advance.

---

[1] Péwé, T.L., and others: "Multiple Glaciation in Alaska: A Progress Report", U.S. Interior Department, Geological Survey, Circular 289, Washington, 1953, 13 pp.

[2] McConnell, R.G.: "Glacial Features of Parts of the Yukon and Mackenzie Basins", Bull. Geol. Soc. America, I, 1890, pp. 540-544; R.G. McConnell, "Report on an Exploration in the Yukon and Mackenzie Basins, N.W.T., "Canada Geol. Surv. Ann. Rept. 1888-1889, 4, part D, 1891, pp. 24D-29D; J. Keele, "A Reconnaissance Across the Mackenzie Mountains on the Pelly, Ross, and Gravel Rivers, Yukon and Northwest Territories", Geol. Surv. Canada Publ. 1097, 1910, pp. 42-46.

[3] Camsell, C.: "Report on the Peel River and tributaries, Yukon and Mackenzie", Canada, Geol. Surv. Ann. Rept. 1904, 16, part CC, 1906, pp. 39CC-46CC; J.J. O'Neill, "Geology of the Arctic Coast of Canada, West of the Kent Peninsula", Report of the Canadian Arctic Expedition 1913-18, 11, Geology and Geography, part A, Ottawa, 1924, pp. 10A-18A; H.S. Bostock, "Physiography of the Canadian Cordillera, with special reference to the area north of the fifty-fifth parallel", Ottawa, Queen's Printer, 1948, pp. 31-35. The Glacial Map of North America (Geological Society of America, 1945) shows the modern delta and Tuk Peninsula as outwash but this is a great oversimplification of the actual conditions.

[4] Downie, M.J., A.G. Evans, and J.T. Wilson: "Glacial Features Between the Mackenzie River and Hudson Bay plotted from air photographs", (abstract), Bull. Geol. Soc. America, 64, 1953, pp. 1413-1414.

It is interesting to note that mammoth teeth and tusks which are so widely distributed in Arctic and subarctic North America are also present in the old deltaic deposits. They have been recovered from sandy bluffs between Tununuk and Kittigazuit, and from the mud bluffs between Cape Bathurst and Stanton. A bison skull, possibly that of a great extinct bison, Bison crassicornis,[1] was collected by natives four miles southwest of Tuktoyaktuk, and similar skulls have been reported from near Stanton by natives.

Physiographic History

The Mackenzie Valley is old and may have been occupied by an ancestral Mackenzie River since the early Tertiary period.[2] During the Pleistocene epoch, the Mackenzie River was probably reborn during interglacial ages.

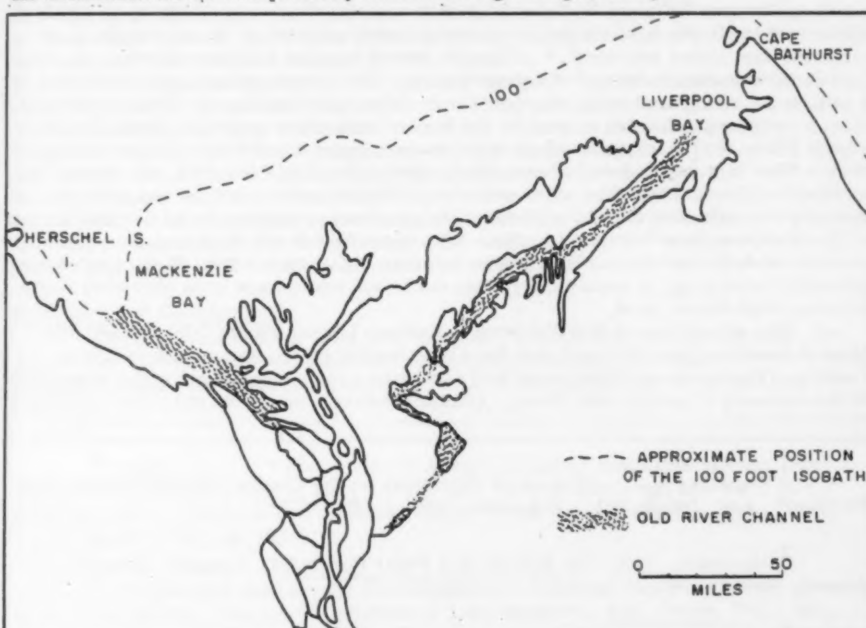


Figure 6.

Two glacially modified channels of the Mackenzie River can be traced seaward. (Figure 6). The estuarine-like Napoiak Channel of the Mackenzie River leads into the Beaufort Sea by the Herschel Island (Mackenzie Valley) Canyon. The sea valley, which slopes northwestward and lies from about 100 to 1,000 feet below the

---

[1] Identification suggested by Dr. M. Y. Williams upon the basis of a photograph.

[2] Hume, G.S.: "Mackenzie River area, District of Mackenzie, Northwest Territories", Canada Geol. Surv. Summary Rept. 1923, part B, 1924, pp. 12B-14B.

level of the surrounding shelf, may represent a glacially modified drainage channel.[1] To the east, another channel leads through the rocky defile of Campbell Lake and probably into Liverpool Bay by way of Sitidgi and Eskimo Lakes. Glaciation has also modified parts of the channel, especially Campbell and Sitidgi Lakes where ice moved along their length. The physiographic significance of the low level Campbell-Sitidgi-Eskimo Lakes outlet for the Mackenzie River to Liverpool Bay has not been lost on the Eskimos. According to Harrison,[2] the Eskimos had a legend that one of their ancestors brought the sea over the land to the Mackenzie River and when the ocean receded, it left the lakes plentifully stocked with fish as a provision for their ancestor's offspring through the ages to come.

Following deglaciation, there was a period of submergence. The amount of submergence was less than in the Arctic coastal areas farther east where it was as much as 500 feet or more.[3] Raised beaches are clearly recognizable up to 100 feet above sea-level and faint strand lines are probably present up to an altitude of at least 200 feet above sea-level.[4] Although raised beaches indicate emergence, the last episode seems to be one of submergence. The submergence could be caused by a still stand of the land while sea-level was rising eustatically, or else by other means such as subsidence caused by the load of sediments deposited from the Mackenzie River.[5] Two distinct types of evidence support the theory of recent subsidence. The first is the drowned coastline, typified by Tuk Peninsula, Liverpool Bay, and the Eskimo Lakes. The eight mile long "Tuk Sound" is a drowned river valley with depths exceeding 50 feet at Tuktoyaktuk Harbour. Anderson and Kugaluk Rivers to the east also have drowned mouths. The second evidence of submergence is the absence of driftwood appreciably above extreme high water level. If the area were gradually emerging, it seems likely that driftwood would have been observed above extreme high water level.

The shorelines of Tuk Peninsula, Eskimo Lakes, Ballie Islands, and the stretch between Cape Bathurst and the Anderson River are being cut back quite rapidly. There are verified reports of shoreline recessions all along the coast within the memory of people now living. Offshore islands have been cut away, sandbars

---

[1] Carsola, A.J.: "Extent of Glaciation on the Continental Shelf in the Beaufort Sea", Am. Journ. Sci., 252, June 1954, p.366.

[2] Harrison, A.H.: In Search of a Polar Continent. London: Edward Arnold, 1908, p.162.

[3] Mackay, J. Ross: "Glacier Ice Movement in the Amundsen Gulf Area, Northwest Territories, Canada", (abstract), Yearbook of the Association of Pacific Coast Geographers, 16, 1954, p.64.

[4] For a contrary opinion see H.G. Richards, "Postglacial Marine Submergence of Arctic North America with special reference to the Mackenzie Delta", Am. Philos. Soc. Proc., 94, 1950, pp.31-37. Richards states there is no evidence of any postglacial marine beaches in the immediate vicinity of Mackenzie Delta.

[5] Richards: op. cit.

have formed or shifted position, harbours have become shallower or unusable, and cut banks with tabular sheets of ground ice have been eroded back as much as 50 feet in a year.

At the northeastern end of Tuk Peninsula there are a number of eliptical north-south oriented lakes. These lakes resemble those of the Alaska Coastal Plain.[1] Similar oriented lakes also occur near Cape Bathurst. Drowning of oriented lakes has taken place near Cape Dalhousie at the northeast extremity of Tuk Peninsula where the interlake ridges interfinger with the sea. These lakes may have been formed or at least modified by strong winds blowing across - not along - the lakes.[2] The cross-wind direction is corroborated by blowouts and longitudinal dunes formed by strong east winds. The occurrence of oriented lakes is of interest, because they seem restricted to coastal plains and they are not present in the modern Mackenzie Delta. A study of the oriented lakes near Cape Dalhousie may help to shed some light on the controversial problem of origin of the Carolina Bays and the oriented lakes of the Alaskan Coastal Plain.

The remarkable conical hills termed "pingos"[3] are restricted to the old delta deposits.[4] Pingos are present in small numbers in other regions, such as Victoria Island, but over a thousand have been mapped in the older deposits of Richards Island, Tuk Peninsula, Nicholson Island and along the shores of the Eskimo Lakes. On the west side of Richards Island several pingos occur in what might be classified as modern delta sediments, but if so, the sediments should probably be considered as only a veneer covering an eroded part of Richards Island. Although there are several theories to account for the origin of pingos,[5] any acceptable theory must explain the close association of pingos with the old deltaic deposits.

Summary and Conclusions

The Mackenzie Delta area is a complex physiographic region because the Mackenzie Valley is old and a number of drainage systems have existed over a long period of time. The modern Mackenzie Delta is sharply delimited by the Richard-

---

[1] Cabot, E.C.: "The Northern Alaskan Coastal Plain Interpreted from Aerial Photographs", Geog. Rev., 37, No.4, October 1947, pp.639-648; R.F. Black and W.L. Barksdale, "Oriented Lakes of Northern Alaska", Journ. Geol. 57, No.2, March 1949, pp.105-118.

[2] Theoretical reasons for the formation of eliptical lakes have been given by D.A. Livingstone, "On the Orientation of Lake Basins", Am. Journ. Sci., 252, No.9, September 1954, pp.547-554. The theoretical circulation of lakes given by Livingstone has been observed in a lake; see Y. Inoue, "The Lake-current and the Prevalent Wind of Lake Yamanaka in Summer - On the Causes of Lake-current", Geog. Rev. of Japan, 25, No.4, April 1952, pp.26-34.

[3] Porsild, A.E.: "Earth Mounds in Unglaciated Arctic Northwestern America", Geog. Rev., 28, 1938, pp.46-58.

[4] From a map drawn by John K. Stager.

[5] Porsild: op. cit.; W.C. Gussow, "Piercement Domes in Canadian Arctic", Bull. Am. Assoc. of Petroleum Geologists, 38, No.10, October 1954, pp. 2225-2226.

son Mountains and Caribou Hills on the west and east, and by older deltaic or fluvial deposits on the northeast. The Mackenzie Delta varies from south to north in the size, shape, and number of lakes. The differences are reflected in the productivity of muskrat trapping areas in the delta. The older terrain of Richards Island and Tuk Peninsula differs from the modern Mackenzie Delta in such features as altitude, relative relief, lake pattern, and presence of pingos. The older terrain is characterized by reindeer grazing.

NOTES ON THE GEOLOGY OF THE MACKENZIE DELTA

G.A. Kellaway

ABSTRACT

Little information has been published regarding the general geology of the Mackenzie Delta region. On the western side of the Delta bedrock appears to consist largely of Mesozoic sedimentary formations. Coal-bearing rocks occur some 25 miles northwest of Aklavik and a six-foot coal seam with almost vertical dip is worked at Moose River Coal Mine. A description of these workings is given.

The eastern side of the Delta shows some variety in its geology. Bedrock areas between Campbell Lake and Dolomite Lake are largely formed of dolomite and magnesian limestone. Dolomite, limestone and reddish slaty shale are seen on the north shore of Dolomite Lake and exposures of shaly material are seen on the east bank of the East Channel eight miles south of the entrance channel leading to Dolomite Lake.

Between Dolomite Lake and the southern end of the Caribou Hills bedrock is concealed beneath unconsolidated deposits covered by bush and muskeg. The deposits appear to consists largely of silt, clay and gravel, and wrap round and conceal the junction of the Caribou Hills formation with the underlying formations. The undulating and rather formless character of this tract of ground and the relation of the deposits to the bedrock at Dolomite Lake suggest that they are glacial drifts.

The Caribou Hills form the most striking feature on the east side of the Delta. They form a steep face or escarpment overlooking the East Channel and rise to their maximum height south of the Reindeer Station. Northwards their altitude gradually diminishes and they terminate against the tundra south-east and the swamps of the Delta of Tununuk. The rocks consist of soft poorly consolidated silty clay, and fine silt and sand with some pebbly or gravelly sand capping the hills locally. Beds of lignite and very thin layers of ironstone were also seen and, where the lignite has been burned out reddened patches and bands appear on the steep hill slopes. The Caribou Hills formation recalls Tertiary lignite-bearing formations described from other parts of Northern Canada and Alaska.

The bearing of these and other observations upon the history of the Mackenzie Delta is briefly discussed.

PROGRESS REPORT ON THE ANALYSIS OF THE CHARACTERISTICS AND DISTRIBUTION OF PINGOS EAST OF THE MACKENZIE DELTA [1]

J.K. Stager

Geographical Branch, Dept. of Mines and Technical Surveys

The peculiar, more or less conical hills along the Arctic coastal plain of North America have attracted the attention of explorers and other investigators ever since they were first described by Richardson.[2] Various theories have been suggested to explain the origin of these "earth mounds" progressing from the first conception of the hills as drifts of sand[3] to Leffingwell's[4] belief that hydraulic pressure bowed up the former flat surface. A.E. Porsild[5] accepts Leffingwell's hypothesis as applying to some types of mounds, but advances another hypothesis which applies to the discrete characteristics of the mounds east of the Mackenzie Delta. At the same time, Porsild[6] offers the Eskimo term pingo as an alternative to "earth mound" used in accounts previous to his.

The literature gives little indication of the exact distribution of pingos and only in three places has any measure of density been noted. Leffingwell[7] counted 30

---

[1] Published with permission of the Acting Director, Geographical Branch, Department of Mines and Technical Surveys. The author was a member of a Geographical Branch field party to the Mackenzie Delta Area in 1954 under the leadership of J. Ross Mackay, with whose encouragement this project was undertaken.

[2] Richardson, John: "Topographical and Geological Notices" in *Narrative of a Second Expedition to the Shores of the Polar Sea, in the Years 1825, 1826 and 1827*, by John Franklin, London, 1828, App. 1, pp. xl-xli.

[3] *Loc. cit.*

[4] Leffingwell, Ernest de K.: *The Canning River Region, Northern Alaska*, U.S. Geol. Survey Professional Paper 109, 1919, pp. 153-155.

[5] Porsild, A.E.: "Earth Mounds in Unglaciated Arctic Northwestern America", *Geographical Review*, 28, 1938, pp. 46-58.

[6] *Ibid.*, p. 46.

[7] Leffingwell: *op. cit.*, p. 150. The text actually reads "From a single triangulation station near Shaviovik River pointings were made upon about 30 mounds within an arc of 140°..." Later in the text, "There are possibly three or four mounds between Canning and Shaviovik rivers; west of the Shaviovik they are abundant. The first conspicuous mound is that on which the triangulation station called Shav is located. This mound ... is estimated to be 80 feet in height." It has been assumed that these stations are one and the same.

pingos from a point 80 feet in altitude through an arc of 140° near the Shaviovik River in Alaska. The density is possibly 1.7 pingos per 10 square miles in this area.[1] An air photograph in Porsild's[2] account has 40 pingos visible on it. The calculated density is approximately 5.3 pingos per square miles.[3] In the same area Porsild has counted 25 pingos from the top of one of these mounds "within a radius of a few miles".[4]

In this project attention has been directed toward obtaining the precise distribution of pingos in the area east of the Mackenzie Delta. Complete vertical coverage of air photographs having a scale of 1:40,000 was examined from the western side of Richards Island to the western side of Nicholson Peninsula and from the sea coast south to a line joining the following points: 69° 20' N. latitude, 129° W. longitude; the southern end of Sitidgi Lake; 68° 30' N. latitude, 134° W. longitude. The western boundary follows the limit of the present Mackenzie Delta. (Figure 2). The location of each pingo identified was plotted on a base map with a scale of 1" - 3 miles. In addition, several characteristics which are visible on the photographs were recorded for each pingo. They are as follows: (See Figure 1).

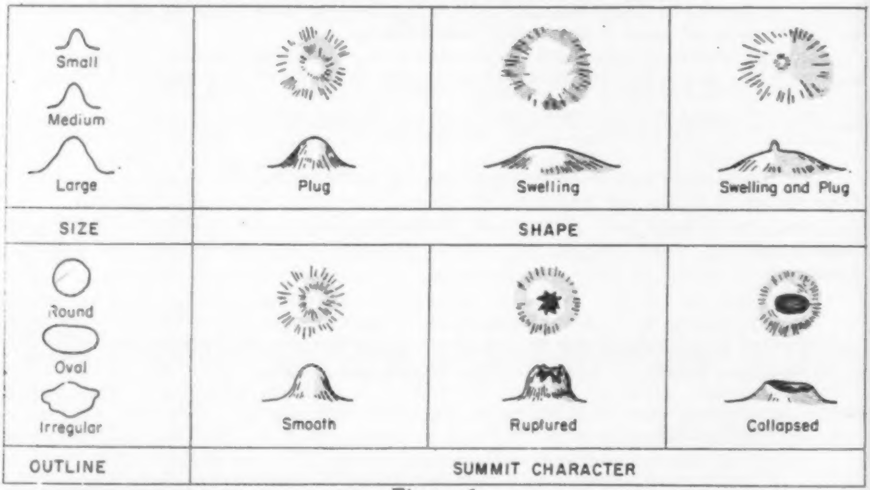


Figure 1.

[1] At an altitude of 80 feet, one can see approximately 12 miles. Through an arc of 140°, this would cover an area of $\frac{\pi \times 12 \times 12 \times 140}{360} = 175.9$ sq. mi. Density $\frac{30}{175.9} \times 10 = 1.7$ pingos per 10 sq. mi. In this calculation it was assumed that Leffingwell could see the base as well as the top of each pingo he counted.

[2] Porsild: op. cit., p.57.

[3] By visual inspection, the limits of the photo were plotted on a map (scale 1" - 3 miles) and the land area roughly measured at 75 sq. mi. The density is then $\frac{40}{75} \times 10 = 5.3$ pingos per 10 sq. mi.

[4] Porsild: op. cit., pp.49-50.

1. Size	i)	small
	ii)	medium
	iii)	large
2. Vertical shape	i)	plug-like, relatively steep sides
	ii)	gentle swelling or up-bowing
	iii)	gentle swelling with plug on top
3. Plan outline	i)	round
	ii)	oval
	iii)	irregular
4. Summit character	i)	smooth top
	ii)	cracked or ruptured top
	iii)	collapsed summit with ring-like crater
5. Patterned ground	i)	patterned ground visible
	ii)	patterned ground not visible
6. Location	i)	in present or former iake basin
	ii)	not in lake basin
7. Immediate environment	i)	partly or entirely surrounded by water
	ii)	surrounded by land

The validity of the observations depend upon accurate identification of pingos on the air photographs.[1] Positive identification can be made quickly for pingos with the typical conical shape, especially if they are ruptured or have collapsed. Large pingos, which often project above the general summit level of the surrounding terrain, can be recognized by this feature. Pingos without these typical and easily recognized characteristics present somewhat more of a problem. Some of the terrain over which pingos are distributed is knobby with rounded hills, where some small hills could easily be misconstrued as pingos. However, the plug shape and round outline betray most pingos. Nearly all of them rise from the flat surface of lakes or lake basins and this flat surface serves to accentuate the shape of the mounds and facilitate identification. Even a slight swelling or bowing-up of the lake floor can be detected but such a swelling was not considered to constitute a pingo unless it was definite in both elevation and outline. Doubtful identifications were ignored.

The classification of pingo size is relative and has been determined without measurement. It is estimated, however, that small pingos are under 30 feet in height, medium pingos are 30 to 80 feet and large pingos are over 80 feet. The plug shape of these mounds is characterized by relatively steep sides with a sharp break in slope where the base of the pingo meets the level surface upon which it rests. Swelling-shaped pingos do not have this sharp change in slope and the base-height ratio of this type is greater than plug pingos. The swelling and plug type is a combination of these two as a plug sometimes develops on top of a swelling. Plan outlines are easily grouped as either round, oval, or irregular. Irregular outlines vary from long, ridge-like mounds through triangular plans to truly irregular outlines. In

---

[1] Field observations in the Tuktuk and Eskimo Lakes area showed that pingos could often be identified on aerial photographs as easily, or more easily, than on the ground.

some cases where pingos have been truncated by wave action and slumping, the reconstructed outline was recorded. Ruptured pingos are those with either wide linear crevasses or star-shaped cracks across the summit. Collapsed summits, on the other hand, leave the sides standing to form an annular mound, frequently having a lake in the centre. Visible patterned ground on pingos ranges from 50 feet to almost 100 feet in the greatest dimension between the fissures making up rectangular to polygonal patterns. Basin areas are easily identified where occupied by water and, even if drained, the former shoreline is distinct on the photograph. The occurrence of water at the base of a pingo is easily recognized.

Following this technique, the locations and characteristics of 1,380 pingos were recorded.

Characteristics

The preliminary counts of pingos with the observed characteristics are given in Table I. Ninety per cent of all pingos were estimated to be either small or medium in size with small pingos in excess of medium sized pingos by eight per cent.

TABLE I

Pingo Characteristics

Characteristics	No. of Pingos	% of Pingos
Small	674	49
Medium	565	41
Large	141	10
Plug shaped	1,123	81
Swelling shaped	222	16
Swelling and plug	35	3
Round outline	976	71
Oval outline	271	20
Irregular outline	133	9
Smooth summit	1,054	76
Ruptured summit	221	16
Collapsed summit	105	8
Patterned ground	722	52
No patterned ground	658	48
In lake basin	1,351	98
Not in lake basin	29	2
Partly or entirely surrounded by water	779	56
Surrounded by land	601	44

Large pingos account for only 10 per cent of the total. On this basis, the large pingos may not be as important as might be concluded from the literature which often records only the altitudes of large mounds. The plug-shape is most common for 81 per cent of all pingos possess this characteristic. Seventy-one per cent of the total

number have round outlines, and 76 per cent are smooth across the summits. The almost even division between patterned and non-patterned pingos reveals little significance. Porsild[1] states that all the pingos in the Mackenzie District are situated in or near shallow lakes or former lake basins. This was found to be true for 98 per cent of those observed. On the other hand, whether the lake basin was wet or dry appears unimportant for almost as many pingos had no water near their bases as had water partly or entirely around them. From these counts, pingos are most commonly located in lake basins and are plug-shaped with round outlines and smooth summits. They are usually either medium or small in size. The existence of patterned ground on a pingo and presence of water near its base is displayed by slightly more than half of the mounds.

With 18 different characteristics possible for each pingo, many combinations can result. Each of the combinations constitutes a distinct type of pingo because a change of but one characteristic modified the type. Of the 648 types that are mathematically possible, only 168 were found to occur (Table II). Many of them are relatively unimportant. Sixty-one types - over a third of the total - have only one pingo

TABLE II

Pingo Types

	No. of Types	% of Types Found	% of Pingos
Pingo types possible	648	--	--
Pingo types found	168	100	100
Pingo types with less than 1% pingos	146	87	37
Pingo types with only one pingo	61	36	4
Pingo types with more than 1% pingos	22	13	63
Pingo types with most frequently recorded characteristics[2]	8	0.5	44

each and 146 types have within each type fewer than one per cent of all the pingos. This means that most of the mounds come within the classification of comparatively few types. Twenty-two types have over one per cent of the total number of pingos each. Thus, 63 per cent of all the pingos fall within the limits defined by only 13 per cent of the occurring types. Eight pingo types encompass the most frequently recorded characteristics as determined from Table I, and 44 per cent of the pingos belong to these eight types.

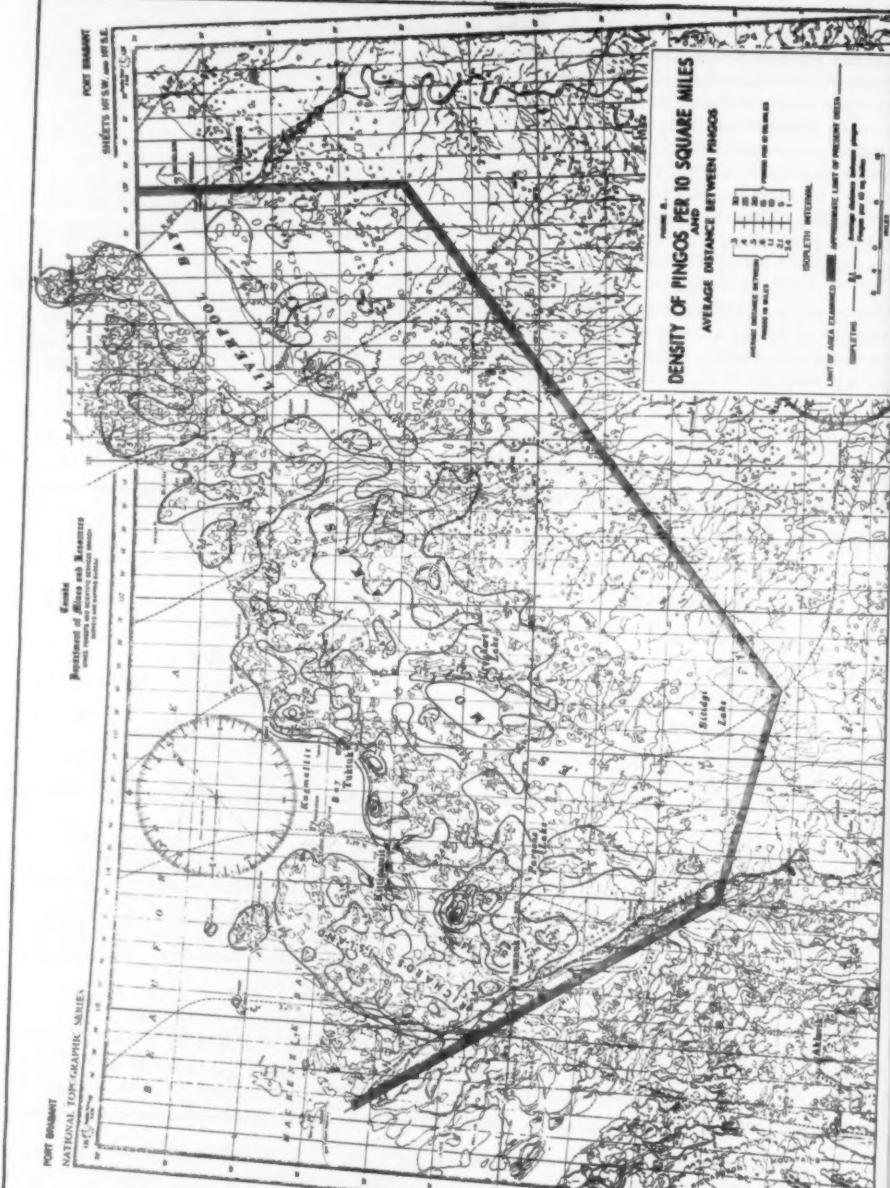
Distribution

The preliminary distribution map of pingos shows the data by means of isopleths along which the density of pingos is constant. (Figure 2). The map was prepared from the original dot distribution map with the aid of a counter circle equal in

---

[1] Porsild: op. cit., p. 55.

[2] Pingos found in lake basins that are plug-shaped with round outlines, smooth summits, and are small or medium in size. They may or may not have patterned ground, and may or may not have water near their bases.


DENSITY OF PINGOS PER 10 SQUARE MILES
AND
AVERAGE DISTANCE BETWEEN PINGOS
ISOPLETH INTERVAL
NATIONAL TOPOGRAPHIC SERIES
PORT BRABANT
Sitidgi Lake

area to 10 square miles at the scale of the dot map, or 1" - 3 miles. The counter circle was moved over the dot map in such a way as to locate the areas of high density and at the same time to obtain representative density measurements for the whole area. At each placement of the circle the number of dots was counted and the value plotted in the centre. Thus, values for the density per 10 square miles were plotted for the entire area. The choice of isopleth intervals was based upon a frequency count of the plotted values.[1, 2]

The investigation has shown that pingos are confined to Richards Island, the peninsula north of Eskimo Lakes and a strip of land averaging 20 miles wide bordering and paralleling the general trend of the south shore of these lakes. A few pingos are located on the present delta flats close to the western side of Richards Island. Beyond this, no pingos were noted in the present delta.[3] It is possible that more pingos could be found along the coast from Stanton toward Cape Bathurst.

The highest concentration of pingos occurs on the south side of the East Channel of the Mackenzie about midway between the point where it leaves the present delta at Tununuk and its mouth near Kittigazuit. Preliminary measurements yielded densities up to 31 pingos per 10 square miles. An arcuate belt of high concentration is located along the coast of Kugmallit Bay and centred at Tuktuk. Over 20 pingos per 10 square miles have been measured at either end of this arc. On Richards Island there appears to be a slight concentration. Some densities over 10 pingos per 10 square miles are present along the western side of the Island.

Beyond these three main areas of high concentration, pingos are unevenly distributed. No mounds are found outside the limit of the one pingo per 10 square miles isopleth. Some areas of modest concentrations of over five pingos per 10 square miles do occur; these seem to be located near the north coast on the peninsula as far out as its tip and on the mainland near the south shore of Liverpool Bay and Eskimo Lakes. The "fingers" west and north of Urquhart Lake possess other areas with this same density and most of Richards Island and the mainland to the south of it have over five pingos in any 10 square mile area.

Summary and Conclusions

There are certain main characteristics common to most of the 1,380 pingos located and examined on the air photographs. Nearly all are to be found in lake basins. Most have round outlines, are plug-shaped, have smooth summits, and are either small or medium in size. The number of characteristics recorded for each pingo, when taken in the various combinations that do occur, has resulted in 168 distinct types of earth mounds. However, a large number fall within the limits of only a few types. Three main areas of concentration are apparent on the distribution

---

[1] Mackay, J. Ross: "An Analysis of Isopleth and Choropleth Class Intervals", Economic Geography, 31, No. 1, 1955, pp. 71-81.

[2] On the map (Figure 2), the density has been expressed in terms of the average distance between pingos as well as the number of pingos per 10 square miles. The values for distance between pingos were calculated by using the formula $1.07\sqrt{\frac{a}{n}}$, where a is area and n is the number of pingos.

[3] Although the air photographs for the remainder of the terrain encompassed by the Port Brabant Sheet, of the 8 miles to 1 inch mapping series, were not examined specifically for pingos, they were studied on three separate occasions. It is on the strength of these examinations that this statement is made.

map with the highest density found along the East Channel of the Mackenzie River between Tununuk and Kittigazuit. The area from Toker Point to Tuktuk and further west has a higher density than the third area of concentration on the west side of Richards Island. Other small but significant densities are present on Richards Island and to the south of it, and some are distributed throughout the rest of the area examined, usually near the north coast of the peninsula or the south coast of Eskimo Lakes and Liverpool Bay.

It might be possible from examination of the recorded characteristics of the pingos and the combinations of these characteristics to arrive at a significant basis for classification of earth mounds. It is intended to inquire further into these characteristics and to plot and examine the distribution of certain types of pingos which may qualify existing explanations of origin or provide leads for further field research.

PHYSIOGRAPHIC NOTES ON FEATURES IN THE MACKENZIE DELTA AREA

J.K. Fraser

Geographical Branch, Ottawa

ABSTRACT

Evidence is presented to show that a group of knobby hills on coalescing alluvial fans along the Richardson Mountains is landslide debris rather than glacial deposit. Associated with the debris are pingo-like features and lenses of ground ice. A heavy layer of silt over remnant snowbanks is attributed to wind deposition.

PERMAFROST INVESTIGATIONS IN THE MACKENZIE DELTA [1]

R.J.E. Brown

National Research Council

Perennially frozen ground (permafrost) is a phenomenon of Arctic and Sub-arctic regions underlying approximately half of Canada, and large areas of Alaska, Greenland, and the U.S.S.R. It generally occurs anywhere in the world where the average annual temperature is below 32° F. The word "permafrost" is now used in a broad sense to describe any material in the earth's crust which remains frozen over many years. In Canada, the thickness of permafrost ranges from well over one thousand feet in the north to a few feet at its southern boundary. Its existence is affected by geology, topography, climate, vegetation, and the type of soil.

Above the permafrost is a thin layer of ground which thaws in the summer due to solar radiation and freezes again in the winter. This layer, which usually consists of soil, is called the "active layer". The depth of this active layer varies. As a rule it is fairly deep in southern areas of permafrost becoming shallower towards the north. Its depth also depends upon the composition of the ground, vegetation, and other factors.

The Mackenzie River Delta, is approximately 50 miles wide and 100 miles long, and is about 500 miles north of the southern boundary of permafrost. It is a low flat area, consisting of deltaic silts with some fine sand and clay, interlaced and dissected by many river channels and spotted with thousands of stagnant lakes.

Unlike a typical delta which fans out from its source, the Mackenzie River Delta is long and narrow, curving from the south at Point Separation to the northwest. Its long narrow shape is determined by the bordering upland on each side. On the west are the Richardson Mountains consisting of Cretaceous sandstone and shale conglomerates. They are a northern extension of the Rocky Mountains and extend in a northwest direction to the Arctic coast. On the east side of the Delta the bordering upland consists of three distinct zones. The first, in the south, consists of extensive Palaeozoic limestones, sandstones, and shales, covered in places with glacial drift and moraine. The second is a zone of glacial drift and moraine extending north along the Delta flank from the Palaeozoic exposures to the Arctic coast. Approximately two-thirds of the distance from Point Separation to the coast, this zone is interrupted for a distance of 30 miles by the Caribou Hills which rise to a height of 600 feet above the Delta. The origin of this landform is uncertain but it is believed to be at least partially glacial.

Investigations in 1953

In the summer of 1953, the Canada Department of Resources and Development, now the Department of Northern Affairs and National Resources decided to erect a new school and teachers' residence at Aklavik. Personnel of the Division of Building Research of the National Research Council carried out soils investigations in the settlement at the proposed sites of the two buildings.[2] Sixteen drill holes

---

[1] Based on field investigations carried out for the Division of Building Research, National Research Council and the Northern Administration and Lands Branch, Dept. of Northern Affairs and National Resources, with whose permission this paper is published.

[2] Philainen, J.A., and G.H. Johnston: Permafrost Investigations at Aklavik, 1953; Tech. Paper 16, Div. of Building Res., Nat. Research Council, 1954.

were advanced with a lightweight drill rig. Each hole was approximately 30 feet deep and 150 soil samples were obtained and tested for their physical properties at the Division of Building Research Northern Research Station at Norman Wells, N.W.T.

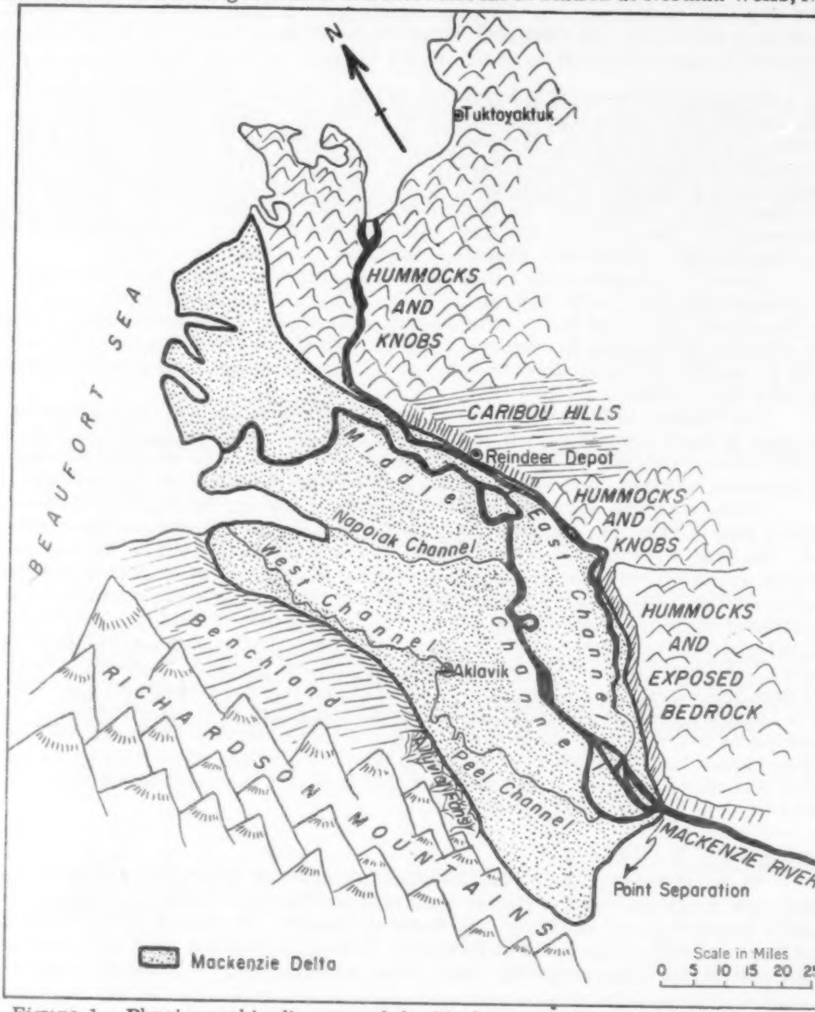


Figure 1. Physiographic diagram of the Mackerzie Delta and adjacent upland.

At the time of drilling in July, the depth of the thawed layer varied from a few inches under moss cover to three feet where the vegetative cover had been removed and the ground more exposed to insolation. These depths do not indicate the true depth to the permafrost table as the summer thaw and the lowering of the frozen ground table proceeds until freezing temperatures occur in late August and

September. Below this table, the soil was continuously frozen in all the drill holes.

Surface water has a pronounced effect on the depth to frozen ground. The Federal Department of Public Works constructed a wharf at Aklavik during the summer of 1953. Several piles were driven into the bottom of the Peel Channel in front of the settlement to a depth of 60 feet and no frozen ground was encountered. This is typical in permafrost areas where the permafrost table is lowered under a water body because of the high specific heat of the heat of the water. However, permafrost underlies the whole Delta and is believed to extend down many hundreds of feet.

Investigations in 1954

Problems with permafrost arise from the fact that soils which contain large amounts of ice become almost liquid when the ice melts. If such adverse ground conditions are ignored in foundation design, serious building failures may result. These failures are caused by movements of the thawed soil.

Because the high ice content of the deltaic silts makes them unsuitable for building foundations, and for other reasons (improper sanitation, danger from flooding, no airstrip), the Canadian government decided late in 1953 that a new townsite should be found for Aklavik. The selection presented an interesting geographical problem because of the need for considering many physical and cultural factors. The poor soils for building which prevail throughout the Delta dictated that the new site be off the Delta. The settlement had to be on a navigable river channel which narrowed the selection to the upland immediately adjacent to the Delta. Aklavik is only a few miles south of the tree line. Because the population consists of both Indians and Eskimos, the new townsite had to be near the tree line to serve both groups. The prevailing wind and local topography had to be suitable for an airstrip. These are only some of the factors which had to be considered in the site selection and indicate the complexity of the problem.

The permafrost investigations conducted on the Aklavik Relocation Survey were dictated by these conditions and were confined to the upland area adjacent to each side of the Delta extending approximately 20 miles north and south of the latitude of Aklavik (68° 15' N., 135° 8' W.).

Aerial photographs are an indispensible tool for permafrost field studies. Permafrost conditions, affected by many physical factors such as insolation, slope, soil and vegetation are frequently manifested by such surface phenomena as polygons, frost boils, and frost mounds. Aerial photographs are, therefore, an aid to interpreting permafrost conditions by studying related features. But the final analysis can only be obtained by work in the field.

Uncontrolled mosaics of aerial photographs covering the entire Mackenzie Delta and adjacent upland were assembled and studied in Ottawa during the winter of 1953-54. Study revealed that there were two areas on each side of the Delta which satisfied the restrictions imposed on the selection.

One area on the west side of the Delta was a series of coalescing alluvial fans originating from the Richardson Mountains and forming a slightly tilted plain about 15 miles long by two miles wide, having a gradient from base to toe of one to five per cent. These fans merge into an undulating benchland extending northwest to the Arctic coast. One possible townsite was situated on the most northern alluvial fan, the toe of which was very close to a navigable delta channel. The other area examined on the west side of the Delta was approximately 30 miles north on the benchland bordering the West Channel.

One area on the east side of the Delta, at the same latitude as Aklavik and 35 miles to the east, was on a series of flats and ridges. These were bordered on the east by an interior upland parallel to the Delta edge and rising to a height of 150 feet. The other area on the east side was 20 miles to the north in an area of hummocks,

ridges and flats bordered on the east, about one mile from the Delta, by a deep gulley parallel to the East Channel.

Drilling and Sampling Methods

Obtaining soil samples of frozen ground with conventional hand methods is difficult and at times impossible. Because of the rock-like consistency of permafrost, its first contact usually constitutes refusal for hand augers. If some penetration is possible, it is by the auger scraping off small flakes of permafrost. Drive samplers such as heavy-duty pipe with a cutting edge, are at times more effective but the method is slow, laborious, and unsure. The difficulty of obtaining permafrost samples has restricted much data on northern soils to description of soils in the annually thawed layer; soil data on permafrost are virtually non-existent.

The need for portable power drilling equipment has been realized for some time by United States agencies engaged in permafrost research. One of the first developments in this field was made by the Frank L. Howard Engineering Company for the U.S. Corps of Engineers. On the basis of the drilling experience in Alaska of the U.S. Corps of Engineers, this Company modified one of its concrete samplers for permafrost drilling. So encouraging were the reports of its first trials in Alaska that the Division of Building Research purchased one of these drilling units for permafrost field studies.

The principles of drilling and obtaining frozen soil cores are similar to those of diamond drilling. A power-driven rotating core barrel with a bit cuts into the frozen soil, producing a cylindrical core. The core barrel is 5 feet long and 3 inches in diameter producing a core of 2-1/8 inches in diameter. The soil cuttings are carried away from the advancing edge of the bit by wash water under pressure. This wash water travels down the inside of the drill rods and then up the sides of the hole to the surface with the cuttings. The frozen core is retained inside the core barrel. Bore holes were advanced to a depth of 30 feet.

There are, however, many differences in detail and technique between drilling in frozen soil and in rock. The greatest difficulty is that of trying to retain the core in its frozen state. The ice content of frozen soils often equals or exceeds the volume of soil. Thus if the core melts, it turns into a soil slurry and is valueless for record purposes.

The time in which a frozen split core melts and thus obliterates ice segregation is very short and ranges from 3 to 15 minutes. Photographs of split frozen cores, therefore, are a most useful supplement to field descriptions. The Division of Building Research has recently developed a portable camera outfit to photograph the frozen cores in colour.

Aklavik Soils Data

The soil at the present site of Aklavik to a depth of 30 feet is predominantly a series of stratified silts, fine sands, and organic material with some clay. The complete absence of coarser particles was remarkable; not even a pebble was encountered in the 16 drilled holes. Organic material ranged from black hairline streaks to strata two feet thick and was composed of a heterogeneous mixture of decomposed and partly decomposed organic matter.

Generally the form of the ice (ice segregation) in the Aklavik soils was of two types:

a) ice which bonded or coated individual particles of soil but was not always discernible to the unaided eye, and

b) ice which segregated or formed layers, lenses, and dikes in size from hairline to 5/8 inch thick.

Random vertical ice lenses and other ice inclusions such as ice in the annular rings of small twigs and scattered spiral inclusions were also present.

Soil Borings in the Bordering Upland

Seven holes were drilled in the upland bordering the west side of the Mackenzie Delta. Four holes were located on the alluvial fans below the Richardson Mountains. Three were drilled in the most northern fan, which had a vegetative covering of willow scrub, moss and grass. The fourth was drilled in a spruce-covered fan six miles to the south. The fifth was drilled in a transition area between the alluvial fans and the benchland to the north. Two holes were drilled in the benchland on the West Channel 30 miles northwest of Aklavik.

Two holes were drilled at each site on the east side of the Delta. On the one at the same latitude as Aklavik, where the new townsite was subsequently located, the soil was a well-graded frozen gravel in which there was ice in the voids. At the other site, 20 miles north, the soil was a silt clay with scattered stones and streaks of undecomposed organic matter.

Massive Ice

Massive ice was encountered in the Delta area. One occurrence was in the form of contorted layers up to 12 inches thick in a knoll in a slump area just below the Richardson Mountains at the south end of the coalescing alluvial fans. Layers of massive ice, up to several feet in depth were encountered in some of the steep cutbanks of the delta channels. It is debatable whether these bodies were formed in situ or were cakes of river ice buried by subsequent deltaic deposition.

Ice Segregation

Comparatively little exploratory work has been done in perennially frozen ground and its physical and mechanical properties are not clearly understood. The ice phase of the frozen soil is its most distinguishing property. It is debatable what causes the soil moisture to collect in layers or lenses, and whether it moves to these centres as a liquid or vapour, or in both phases.

Generally frozen soils can be divided into two major groupings on the basis of appearance:

1) Homogeneous frozen soils - These are soils in which all the moisture is frozen within the natural voids existing in the soil, without observable accumulation of ice crystals, ice lenses or frost forms exceeding in volume such natural void spaces.

2) Heterogeneous frozen soils - These are soils in which a part of the water in the soil is frozen in the form of observable ice crystals, ice lenses or other frost forms, occupying space in excess of the original soil voids.

Generally all gravelly and sandy soils are not susceptible to significant ice segregation within the soil mass during freezing. Therefore, they usually occur as homogeneous frozen soils. In permafrost areas, ice wedges or other ice bodies may be found within such soils, but it is considered that their mode of origin may be different. Finer-grained soils may also be homogeneously frozen if insufficient moisture is available to permit ice segregation.

Generally all silt and clay soils, and gravelly and sandy soils containing high proportions of fine-grained soils are susceptible to occurrences of ice segregation within the soil mass and, therefore, occur as heterogeneous frozen soils if frozen at normal rates with water readily available.

Both types of ice segregation are frequently found in similar soils so that the form of the ice segregation appears to be the result of the rate of freezing and the amount of moisture available at the time of freezing.

Conclusion

Soil and permafrost conditions are extremely important factors affecting habitation in the North. The ground conditions encountered at the various potential townsite areas therefore, were prime factors in determining their suitability for building sites. The predominance of fine-grained soils with high ice contents made the present site of Aklavik unsuitable. Similar conditions at all but one of the explored potential sites contributed to their elimination as suitable building areas. The gravel soils, with relatively low ice content, were one of the deciding factors in the selection of the new townsite.

Permafrost investigations in Canada are in their infancy partly because of the difficulty of sampling without heavy power equipment or laborious excavation. These investigations in the Mackenzie Delta and adjacent upland are merely a beginning to what is hoped will be a widespread program of observation and the gathering of data throughout the Canadian North.

NOTES ON AKLAVIK RELOCATION PROJECT, 1954

C.L. Merrill

Department of Northern Affairs and National Resources, Ottawa

ABSTRACT

During the summer of 1954 rather more scientific field studies than usual were sponsored by the Canadian Government in the comparatively little known Mackenzie River Delta. One of these studies was the site survey for Aklavik.

Following the Government's proposal to relocate Aklavik, a small but growing settlement built on low, unstable ground, in the delta, a team of scientists spent the period from April to August 1954, investigating possible sites for a new town. Much of the material presented in this paper was obtained by the author while serving as a member of the Aklavik Relocation Survey Team. Personnel on the survey team consisted of five engineers and three specialists in geography and geology representing the following federal departments: Department of Northern Affairs and National Resources, Division of Building Research of the National Research Council, Department of Mines and Technical Surveys, Department of Public Works, Department of Transport, Department of National Health and Welfare. The use of this material has been possible by the kind permission of Colonel F.G.H. Cunningham, Director of the Northern Administration and Lands Branch. A number of social, economic, and physical factors, which defined the site requirements, limited the search to places where a navigable channel approached high ground along the delta flanks. The best place available was a location 33 air miles east of Aklavik. In November 1954, a decision was made to relocate Aklavik at this place. Site development work will be done this year with the new construction and moving operations extending over a four year period.

The survey was carried out from a series of base camps under canvas, at or near the potential sites. The early start, two months before break-up, permitted the examination of each location during winter, break-up, and summer conditions. Aerial reconnaissance was made by helicopter, and as the seasons progressed, tractor, dog team, outboard craft, scow and barge, provided surface transportation. Soils data were obtained from frozen cores secured with a special drill developed by National Research Council engineers for use in permafrost, and from test pits. Rough surveys were made to indicate the availability of materials for roads and aggregate, the area and drainage of the surface, and the availability of a site for an airstrip. Hydrographic and related surveys were made to establish the navigability of the access channel, the location for the wharf, and the most suitable provision for a domestic water supply.

Several additional studies, primarily of scientific interest, were carried out by members of the survey as opportunity was presented in the course of the primary work. It is gratifying to note that Mr. Roger Brown and Mr. Keith Fraser will present papers today recording work of this nature, carried out while participating in the Aklavik survey. A sharing of ideas in the form of the work mentioned above, and in contacts with other scientific parties in our area, was most beneficial in maintaining an interest and awareness in our work, through a long field season.

THE ST. LAWRENCE SEAWAY FROM QUEBEC CITY TO CORNWALL

P. Camu

Geographical Branch, Ottawa

One of the objectives of the St. Lawrence Deep Waterway Project, as its official name implies, is to deepen the channel of the river to a minimum depth of 27 feet and build the necessary canals.

The St. Lawrence ship channel, the name given to the portion of the St. Lawrence estuary and river which extends from Pointe-au-Père (Father's Point), a few miles east of Rimouski, to Montreal, has already been deepened to 32 feet. Lighthouses, buoys, dredging and maintenance of the channel as well as traffic regulations are under the jurisdiction of the Federal Department of Transport. The harbour of Montreal is now the head of oceanic navigation, excluding the fact that specially built oceanic vessels ply between European and Great Lakes harbours.

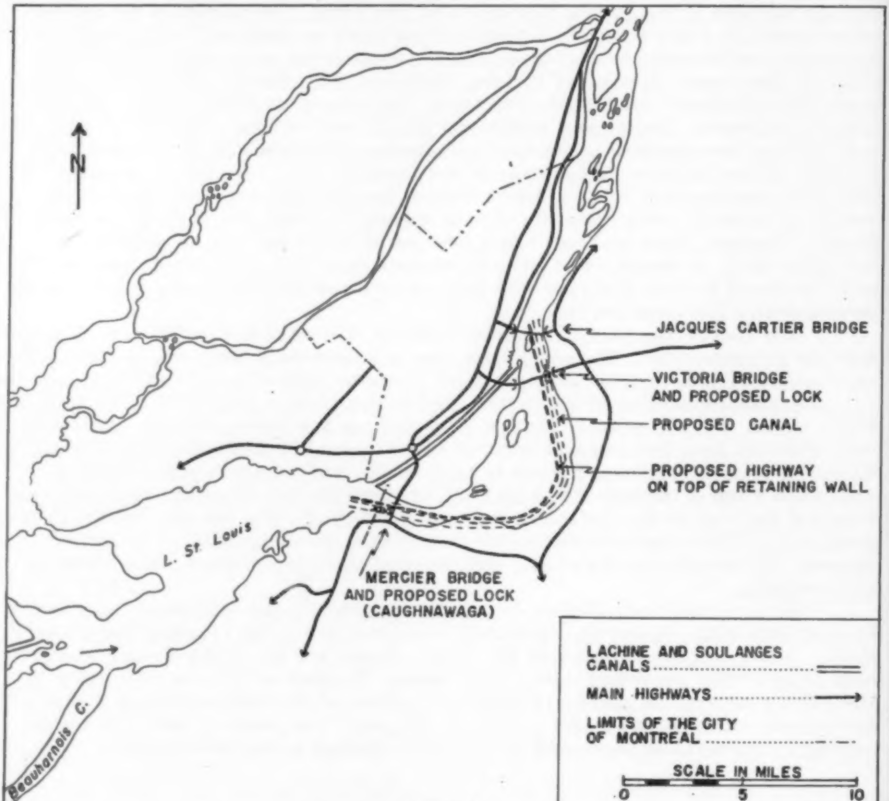


Figure 1.

Below Montreal, the Seaway Project has no direct effects on the landscape; no engineering works will change the face of the shores. There are some economic effects however that might increase or decrease the traffic of the ports of Quebec, Three-Rivers and Sorel. The transshipment of grain and other commodities for instance, might be done directly in the Great Lakes ports in the future. If, however, the transshipment function remains in the lower St. Lawrence harbours, it might increase the total cargo tonnage, involving the construction of new harbour facilities. In order to determine what will happen, local Chambers of Commerce and Boards of Trade have undertaken economic, planning, and port studies.

The Iron Ore Company of Canada for its own use has already built a transshipment centre just a few miles below Montreal, at Contrecoeur, where the largest Great Lakes vessels can manoeuver at ease.

In Montreal, the situation differs. (Figure 1). As the present head of oceanic navigation, will Montreal lose its transshipment function when ocean vessels are able to load and unload directly in the Great Lakes ports? It may be so. The transshipment and transit trade varies between 10 per cent and 30 per cent of the total cargo tonnage. It would be a serious loss to Montreal; but apparently it will not turn out to be so. The harbour of Montreal would lose approximately 8.5 per cent of its total

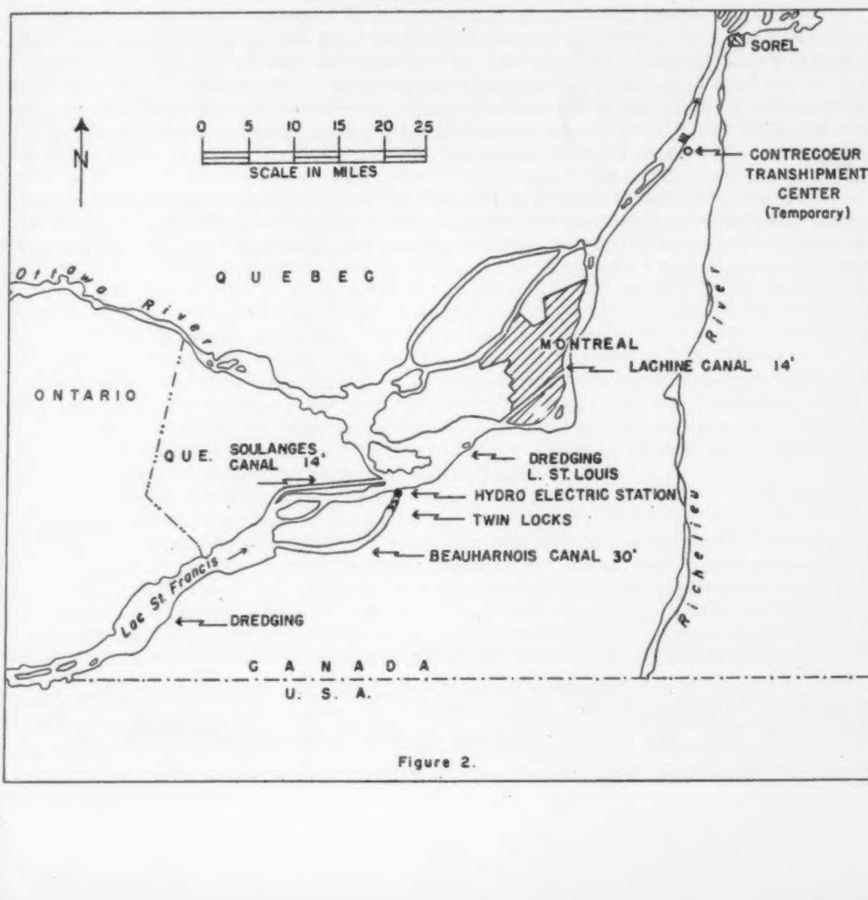


Figure 2.

tonnage but there are good reasons to believe that a potential traffic, not due to regular traffic increase, but to a new contribution brought about the project itself, will add to the anticipated traffic.[1]

At the western entrance of the port of Montreal, is the beginning of the Lachine canal, which has a minimum depth of 14 feet. Together with the Soulanges and St. Lawrence canals, it is the main bottleneck of the Great Lakes-St. Lawrence Seaway.

The Lachine canal will continue to be used for industrial purposes even after the construction of a new Lachine canal in the river itself. The new canal will be built along the right shore of Laprairie basin, from Caughnawaga (Indian Reserve) to Jacques Cartier bridge. (Figure 2). There will be two locks, one at Caughnawaga (Mercier bridge) the other at Victoria bridge. On top of the wall separating the canal from the river, a super-highway may be constructed. Among the problems to be settled is the construction of tunnels and approaches of bridges crossing the new canal. The population of the six municipalities of the South Shore, opposite Montreal, is approximately 75,000 inhabitants, a large number of whom depend on the cross-river communications.

The channel in Lakes St. Louis and St. Francis will be dredged to 27 feet. The water level in Lake St. Louis will be maintained at 71 feet above sea-level.

The connecting link between these two lakes, the Soulanges canal, will be abandoned and replaced by the Beauharnois canal built during the thirties, according to Seaway specifications. (Figure 2). A twin lock remains to be built on the west side of the huge hydro-electric station, located at the north entrance of the canal. In the Lachine area, as yet at the planning stage, is the development of a power station of a capacity of 1.2 million h.p. to be erected a few hundred feet below Victoria bridge. An alternative site has also been selected near the Lachine rapids, with a potential capacity of 800,000 h.p.

Fearing the consequences of the project, especially the implications for its ports, the Province of Quebec was opposed to the St. Lawrence Seaway. A shift of opinion has occurred in the past several years. The question "what are we losing?" has been replaced by "what shall we gain?"

---

[1] Camu, P.: "Effects of the St. Lawrence Seaway Project on the Port of Montreal". Translation of an article published in Actualité Economique, 28, No. 4, jan.-mars, 1953, pp. 619-637. Reprints available in the Geographical Branch.

THE INFLUENCE OF THE ST. LAWRENCE SEAWAY UPON THE CORNWALL-PRESCOTT AREA, ONTARIO

Harold A. Wood

McMaster University

It is the purpose of this paper to summarize the results which construction of the St. Lawrence Seaway and Power Project will bring to bear upon the area lying between Cornwall and Prescott in eastern Ontario.

This is the area which is normally first thought of in connection with the St. Lawrence Seaway. Although navigation will extend for hundreds of miles in each direction, surmounting many other obstacles no less formidable than the International Rapids to be found here, this small section of the St. Lawrence is still so closely associated with the Seaway that it has even been referred to in the press as "Seaway Valley".

It is, of course, not difficult to explain the wide public interest in this 40-mile stretch of the river. For this has been the last bottle-neck in the navigation system, and though for reasons which are found more in the realm of politics than that of engineering, the area has received all the more attention for that fact. Secondly, this is the only part of the waterway in which it has been thought necessary and desirable to inundate an extensive settled area.

Looking now upon the effects of construction of the waterway upon the Canadian side of "Seaway Valley", the most obvious result will be the submergence of approximately 13,000 acres of land including all or parts of eight communities, Provincial Highway No. 2 and the main Canadian National Railway line. There will also be a vast increase in the amount of hydro-electric power produced at Cornwall and an easing of international travel as new roads will cross the dams which are to be constructed at Cornwall and Iroquois. In addition, of course, there will be an improvement in river navigation facilities.

There will also be a change in the character of the shoreline and of the river itself. A number of new islands will be created and the total length of the shore will be increased by about 50 miles. The river bank will tend to be low and imperfectly drained and the offshore slope will be very gradual, especially from Wales to Morrisburg. Beaches will be slow in formation because clay will comprise most of the new shore and neither river currents nor wave action will be particularly effective in carrying away the finer particles and distributing sand and gravel along the shore. The river itself will be transformed from a rusing stream into a quiet lake, some 30 miles in length and up to four miles wide.

Turning now to an examination of the effects of these changes on the human geography and the economy of the area, we observe first that from the agricultural point of view there will be a loss of some 235 farmsteads and the equivalent in acreage of about 180 farms of average size for the area. These farms are among the best within the river front townships and there will thus be an appreciable decline in the rural assessment. This will not involve, however, any major disruption of the local agricultural economy. Most of the farms specialize in dairying and, in particular, in the production of cheese and there is little areal interdependence except for the usual rural urban relationships. These will not suffer greatly as the river front towns are to be relocated, not eradicated, and, besides, feed supply stores and cheese factories are generally located well outside the area to be submerged. Even the cheese factories should not find their operations hampered by the reduction in dairy farms since their chief problem has been not the supply of milk but the disposal of the finished product.

The category of land use in which the loss will be the greatest in proportion to total acreage is actually that of orchards. A number of apple orchards have been planted along the river bank to benefit by the good soil and air drainage and in most cases it will not be possible to relocate these further north for edaphic and climatic reasons. Nevertheless even in the realm of fruit growing the loss can scarcely be considered to be serious. The largest amount of land devoted to this use is between Iroquois and Morrisburg where the submergence will be slight and most of the fruit trees will escape.

The most perplexing problem arising from the removal of land from agricultural use will undoubtedly be found in the relocation of the approximately 200 farm families which will have to move out of the area to be submerged. Some of these may well be resettled in the area immediately to the north, for within the five townships which front on this section of the St. Lawrence there are to be found no fewer than 205 abandoned farms. In most cases, however, these farms were abandoned because of poorly-drained, stony or infertile soils or because of their isolation and it is unlikely that they will prove particularly attractive to the displaced persons of the river front. A decline in rural population will undoubtedly accompany the decrease in agricultural land, though the former may be of smaller dimensions than the latter.

Adjustments to the transportation system require little comment. In addition to the new north-south road links previously mentioned, there will be a new and badly needed four-lane east-west highway running a mile or so away from the river. Highway No. 2 which now follows the St. Lawrence very closely, will be moved back where necessary as will the Canadian National Railway. A scenic drive will link with the mainland a number of the new islands which will be created in Osnabruck and Cornwall townships.

Of considerably greater complexity is the problem of the relocation of towns and villages, for not only must it be recognized that the communities involved have changed their functions appreciably in the past and may well change them again in the future, but local public opinion is very strongly developed on this point and cannot be ignored.

The villages and towns which are to be relocated were originally points of landing and embarkation above and below stretches of fast water in the St. Lawrence River. When the first canals were built, heads of power were created at the lower ends of the canals and permitted some industries to develop in these locations. Nevertheless, industry was later discouraged by the threats, repeated for the past half century, that a Seaway was to be built which would bring about the inundation of these communities. In the end, the only active function which all could retain and the function which is still the chief mainstay of Morrisburg, Aultsville, Farran's Point and Wales, was found in the supplying of goods and services to adjacent rural areas. And it will be noted that this function is one for which the locations of these towns are not particularly favourable since, of necessity, each lies on the periphery rather than in the centre of its trade territory.

Only one town, Iroquois, has continued successfully to combine industry with commerce while the three villages closest to Cornwall, Mille Roches, Moulinette and Dickinson's Landing have become virtually dormitory suburbs of that city.

The number and the spacing of towns and villages were therefore determined by historical factors no longer operative and when redevelopment was contemplated it was immediately evident that a reduction in the number of communities and a consequent increase in their size had much to recommend it. Larger centres would more vigorously compete for rural trade as well as for industries and could, furthermore, afford a higher level of services for their inhabitants.

Nevertheless, for political reasons it has not been possible to push the ideal of centralization to its logical conclusion. One obstacle is seen in the reluctance of any township to permit the loss in assessment which would be the result of the re-

moval of a village from within its borders to the territory of another municipality. Hence one new town is planned for Cornwall township incorporating the villages of Moulinette and Mille Roches, while a second, in Osnabruck township, will represent a union of Wales, Dickinson's Landing, Farran's Point and Aultsville.

The situation is somewhat different in Matilda and Williamsburg townships, for the towns of Iroquois and Morrisburg and locally self-governing and township finances do not enter the picture. Nevertheless, there has developed, without any apparent valid cause, a violent public hostility to what is termed a "shotgun marriage" and it is therefore not feasible to attempt amalgamation at the present time. Present plans call for the redevelopment of these two towns on sites adjacent to their existing locations. The status quo may, therefore, remain unchanged for some time; Iroquois, maintained largely by industry and commercially subsidiary to Morrisburg, but nevertheless always threatening to assume an equal stature with its neighbour as a service centre and thus capture from Morrisburg much of the trade which at present supplies about 90 per cent of the total income of that town.

This situation is unfortunate, for the area between Cardinal and Morrisburg is really beyond the dominating influence of any large city and there is in consequence a need here for a strong commercial centre which would also be in an excellent position to attract many types of industry.

The new town in Cornwall township also faces difficulties. Evidently it is the desire of the planners to produce here an independent community, as if it were their purpose to perpetuate the function of dormitory suburb they would surely have placed the new community closer to the city of Cornwall. But how will this new town maintain itself? It will not be by commerce, for the proximity of Cornwall will prevent the new town from acquiring a trade area of its own even approaching the size necessary for the support of its proposed population. Clearly, then, industry will be required at the very outset and unless it is forthcoming this new community will become merely a rather poorly located residential satellite of Cornwall.

The new town in Osnabruck, on the other hand, has brighter prospects. It is in an excellent position to serve a large trade territory. Indeed, its success in this direction is likely to be so marked that it will bring about a compensating decline in the inland commercial towns of Newington and Finch. This does not mean that this new town will be able to survive on local trade alone, for if it is to provide employment for the entire population of the four communities incorporated within it, some industry will be required here as well.

The importance of industry in the future of the area can, indeed, scarcely be over-emphasized. But if it is true that the existence of some and the well-being of all these communities will depend in no small measure on the extent of industrialization which takes place, it is also true that predictions in this field are far more speculative than those which have to do with commercial developments. Nevertheless, it is evident that the area as a whole will have many industrial advantages. Chief among these are a location astride the main routeway between the two main population clusters of Canada, an abundance of cheap and reliable electric power and a large volume of exceptionally pure water for industrial use.

It will be therefore surprising if manufacturing is not soon found, in greater or lesser degree, in all the river front towns. Nevertheless, the preferred location for industry in the future as in the present will undoubtedly be the city of Cornwall. Its peculiar advantages include an established labour force, closest proximity to the source of power and easy disposal of industrial wastes in the turbulent water below the dam. Cornwall, in fact, has everything to gain and nothing to lose through the carrying out of the Seaway Project. Apart from the normal problems of urbain growth the only attendant difficulty is that the city's water purification plant will not be able to cope with a greatly increased turbidity in the river during the period of construction.

For Cardinal, to the west of the area of major submergence, the benefits will be relatively even greater. This town suffers from two major drawbacks, the more serious being its division into two sections by the existing canal. The only link between the two parts of Cardinal is provided by a single swing bridge, and there arise obvious problems in the provision of urban services. Also, since the main part of the town is now on an island, Cardinal has seen its mainland trade area experience a marked contraction.

With construction of the Seaway, the present canal will be filled in at this point and Cardinal will once again be able to operate as a normal town.

The second problem at Cardinal which will also disappear when the Seaway becomes an actuality, is in the supplying of corn to the Canada Starch Company, which is the town's only industry. The bulk of the grain is brought in by lake vessels but due to the shoaling of the river, each ship must reduce its draft by discharging a large part of its cargo at Port Johnstown before it can proceed the remaining five miles downstream to Cardinal. The corn unloaded at Port Johnstown must then complete its journey by track or train. This economic handicap developed as lake boats increased in size during the past half century and its removal will certainly benefit the company and, through it, the town.

Looking now at Prescott and its suburb, Port Johnstown, it is clear that some decline in commercial activities is to be anticipated as this town ceases to be the lower limit of navigation for lake freighters. Nevertheless, the industrial function far outweighs in importance that of transshipment, and industry will advance, not regress. Prescott, therefore, will continue to expand, though not as rapidly as will Cornwall and other towns closer to the new power dam.

A final consideration is the recreational use of the shore. At present although the area is scenic the river is not particularly useful, being too swift and treacherous to permit much boating, swimming and fishing. Furthermore access to the water is almost impossible along about 20 miles of river frontage where navigation canals follow the shore, and rather difficult in many other places due to the presence of steep high banks. Further disadvantages are seen in the rapid deepening of the water offshore and the scarcity of beaches. As a result of these conditions, although the river bank is fairly well patronized by local people, very few vacationers from outside the area spend their holidays here.

Some of these drawbacks will disappear with the redevelopment of the shore; some new ones will be created. On the whole, however, there will be a marked rise in the recreational potential. The concentration of canals in one or two places and the over-all increase in the length of the shoreline mentioned above will result in a tripling of the usable river frontage, and the river, though possibly less scenic, will be far more suitable for a variety of aquatic activities.

The major drawback for recreation will be the character of the new shoreline, but artificial drainage and the provision of man-made beaches can do much to overcome its natural limitations and the area should develop into a major summer playground.

In conclusion, it is evident, that despite a loss in agricultural production, the area will witness an improved organization of its urban centres and a growth of industrial and recreational activities which will bring a marked acceleration in the economic tempo and a general increase in prosperity. However, the developments which are to be undertaken are so many and varied that a comprehensive and authoritative planning scheme is essential to the success of the entire enterprise. Fortunately, there is abundant evidence that such a planning programme does, in fact, exist and is being put into operation.

INDUSTRIALISATION ET STRUCTURE DE L'EGLISE DANS LE DIOCESE DE TROIS-RIVIERES. DYNAMIQUE DES MILIEUX SOCIAUX

Louis-Edmond Hamelin et Colette L. Hamelin

Université Laval

Nous pourrions dire qu'il y a eu plus d'un diocèse de Trois-Rivières. Dans le temps et dans l'espace, nous en voyons deux: l'un dans la seconde moitié du XIX^{e} siècle; son territoire chevauchait le Saint-Laurent pour englober Nicolet; les fidèles habitaient surtout la Plaine et pratiquaient de préférence le genre de vie agricole; la population s'est élevée jusqu'à 150,000 habitants; mais des partages territoriaux et des mouvements d'émigration ont réduit l'unité religieuse à guère plus de 60,000 fidèles à la fin du siècle. Le second diocèse sera celui du XX^{e} siècle; déjà, l'hinterland religieux ne s'étend plus que sur la rive gauche du Fleuve; la population s'est centralisée dans la vallée du Saint-Maurice; les fidèles sont des urbains salariés; l'activité économique est basée sur le travail industriel; la population dépasse 200,000 habitants. Les vagues d'industrialisation, axées sur l'exploitation de la forêt et des ressources hydroélectriques régionales, ont déferlé sur l'ancienne Mauricie rurale avec une rapidité et une puissance effarante. Elles sont moins en train de transformer l'ancien diocèse que d'en créer un absolument nouveau.

Des cadres, une morphologie sociale ont dû être créés eux aussi pour répondre au nouvel ordre des choses. On a dû, par exemple, ouvrir des paroisses, trouver de nouveaux prêtres ... Les problèmes d'ajustement des structures ont eux-mêmes été compliqués par le rythme et l'ampleur de l'évolution. En effet, de nouvelles paroisses ont eu besoin de prêtres avant même d'en "produire" (en moyenne, une paroisse utilise deux vies de prêtres avant d'offrir son premier enfant à l'Evêche); par ailleurs, il faut toute une génération pour bâtir un ministre de Dieu alors que l'émigration d'un habitant vers la ville en fait presque du jour au lendemain un salarié et un fidèle urbain. Un autre exemple illustre le décalage presque fatal entre des éléments dont le cycle de renouvellement n'est pas le même: une révolution économique rajeunit une population de fidèles beaucoup plus rapidement qu'elle ne le fait pour les clercs. Ainsi, durant la période de transition, de construction d'un diocèse urbain à partir de cellules rurales, les cas d'inadaptation de la structure religieuse au nouveau genre de vie peuvent être très nombreux et graves, surtout si l'Eglise dirigeante n'a pas su prévenir le devenir du diocèse.

Puisque le diocèse de Trois-Rivières en est encore au stade d'évolution rive, les relations entre les termes du binôme: clercs, fidèles, peuvent bien n'être pas parfaitement fonctionnelles. La situation devrait être examinée sous divers angles. Dans cet article, nous allons nous en tenir aux classes sociales, d'une part, chez les clercs séculiers et, de l'autre, chez les fidèles.

Les fidèles

Nous pouvons avoir un rapide aperçu du genre de vie prédominant dans le diocèse en consultant le tableau des industries qui emploient les travailleurs régionaux. Les chiffres sont ici assez représentatifs de la situation, bien que le diocèse ne soit pas enfermé à l'intérieur des trois comtés de Maskinongé, de Champlain et de Saint-Maurice. D'après le tableau I, le groupe d'industries qui engagent le plus de travailleurs régionaux rassemble les entreprises de fabrication. Le pourcentage est nettement dominant en s'établissant à tout près de 40 pour cent. Le chiffre est d'autant plus remarquable qu'il dépasse la proportion provinciale fixée à 30 pour cent; donc la Mauricie est encore plus industrielle que l'ensemble du Québec. Ce qui donne

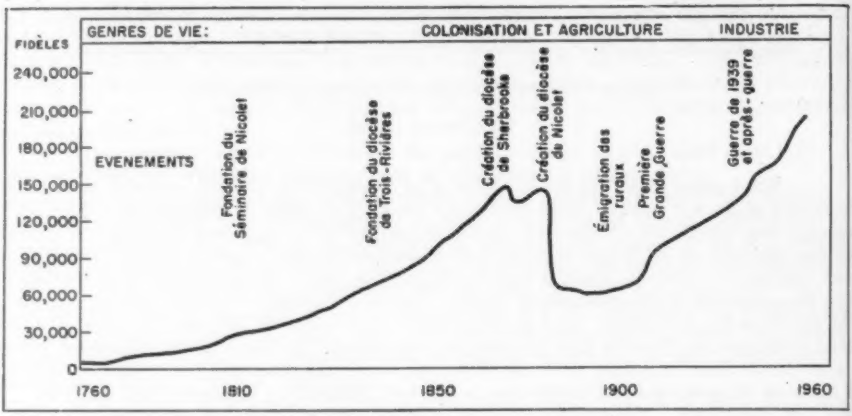


Figure 1. Evolution démographique du Diocèse de Trois-Rivières. Au point de vue démographique, il y a deux diocèses de Trois-Rivières: le premier se termine a la fin du XIX^{e} siècle; l'industrialisation en a fait un second au XX^{e} siècle.

Source: M. Trudel, H. Biron, G. Panneton, Canada ecclésiastique, Annuaire du diocèse, P. Pepin, Recensement du Canada.

pleine valeur à ce pourcentage élevé, c'est que ce groupe est à lui seul plus important et de beaucoup, que chacune des trois catégories suivantes composées de plusieurs groupes réunis. Il appert donc qu'une classe de fidèles va dominer par le nombre toutes les autres. La prédominance de la classe ouvrière est chose évidente. Monsieur Raoul Blanchard écrivait en 1950 au sujet de Trois-Rivières qu'elle était devenue au XX^{e} siècle une ville industrielle. "Comme les familles ouvrières sont celles qui ont le plus d'enfants, on peut évaluer la population vivant de l'industrie à 80 pour cent du total".[1] Ce qui est vrai de Trois-Rivières, le centre le plus populeux du diocèse, l'est peut-être encore davantage des villes de la vallée moyenne du Saint-Maurice dont les fonctions administratives et commerciales sont moins accusées. L'activité industrielle, par ailleurs, se reflète dans la nature des opérations commerciales. Pierre Camu a reconnu dans ses études que le port de Trois-Rivières exerce une fonction industrielle au service de la Mauricie manufacturière.[2] L'Evêque de Trois-Rivières lui-même rappelait récemment l'importance de l'industrie dans son diocèse. Il importe donc de bien prendre conscience du fait industriel dans la région. Cela met en relief un certain nombre de problèmes qui auraient moins de chances de se poser dans un univers où les horizons de travaux seraient plus variés et mieux équilibrés. Il faudra revenir sur ce fait pour rechercher si le genre de vie installé dans le diocèse depuis cinquante ans est aussi favorable que l'ancien au recrutement des vocations et pour confronter la classe sociale des clercs avec celle des nouveaux fidèles.

---

[1] La Mauricie, p. 133.

[2] Camu, Pierre: Le port et l'arrière-pays de Trois-Rivières, dans Geographical Bulletin, no. 1 (1951), p. 30-57, 10 tableaux, 14 figures.

TABLEAU I

Groupes d'industries, main d'oeuvre active, comtés de Champlain, de Saint-Maurice et de Maskinongé, 1951[1]

Groupes	Pourcentage
Fabrication	38 (Province de Québec 30%)
Transport, communication, commerce et finance	17
Services	16
Activités primaires dont agriculture	15
Construction	8
Divers dont décimales	6
Total	100

[1] Recensement 1951, vol. 4, tableau 18.

On se doutait peut-être que le diocèse fût autant industriel, mais probablement pas qu'il fût si peu agricole. Le nombre de travailleurs engagés dans l'agriculture est compris dans celui de la catégorie d'activités dénommées primaires. Le pourcentage des employés de ferme est donc au-dessous de 15 pour cent. De fait, un calcul distinct permet de le fixer à 11 pour cent seulement. Cette donnée est inférieure à la moyenne de la Province. Pour comprendre le faible pourcentage des travailleurs agricoles dans le diocèse, il faut se rappeler qu'il existe toute une région centrale recouverte de sable, de cailloux ou de crans rocheux. Relativement, l'effacement de la population agricole rend encore plus prépondérante la place de l'industrie et établit une coupure nette avec le "premier" diocèse de Trois-Rivières voué à l'agriculture.

Un pas et nous glissons du genre de vie au statut social. Nous avons vu que les fidèles du diocèse, pour la plupart, sont employés dans l'industrie soit directement, soit indirectement par l'intermédiaire d'entreprises tertiaires qui manutentionnent les denrées industrielles. Mais, sont-ils employeurs ou salariés? S'ils sont salariés, le sont-ils pour un travail manuel ou intellectuel? Après réflexion et en tenant compte des limitations statistiques, nous avons individualisé quatre classes sociales dans l'univers des travailleurs. Il aurait été préférable de multiplier les catégories, mais celles que nous avons reconnues ont l'avantage de se retrouver dans les classes sociales auxquelles appartiennent les prêtres régionaux. Ainsi, des comparaisons utiles seront possibles. Nos quatre groupes peuvent être successivement étiquetés: cultivateurs, "professionnels",[1] gérants ou propriétaires industriel ou commercial, salariés de diverses catégories. Le tableau II met en valeur le grand nombre des salariés; ceux-ci sont pour nous des gens qui travaillent dans des

[1] Les médecins, avocats, notaires, ingénieurs ... qui vivent de la clientèle de leurs bureaux.

TABLEAU II

Classes sociales dans les comtés de Champlain, Maskinongé, Saint-Maurice, d'après les catégories des travailleurs, 1951[1]

Classe	Pourcentage de l'ensemble
Agriculteurs	11
Salariés	76
Propriétaires industriel ou commercial	6
"Professionnels"	7
Total	100

[1] Recensement 1951, vol. 4, no. 10.

entreprises autres que les exploitations agricoles et que les divers bureaux des "professionnels". En pratique, les salariés sont dans la fabrication, les services, le commerce, la construction, les transports, ... Ce sont évidemment les villes qui, relativement, en ont le plus. Trois-Rivières, Cap-de-la-Madeleine, Grand'Mère et Shawinigan ont plus de 80 pour cent de leurs travailleurs qui sont des salariés dans le sens que nous donnons à ce terme. Très loin en arrière de ce groupe sont les agriculteurs dont le pourcentage ne dépasse guère 10 pour cent. C'est un groupe qui s'individualise bien. Ces deux catégories ont ceci de commun qu'elles s'opposent sur le plan revenu aux deux autres classes: les cultivateurs et les salariés de l'industrie ont des revenus modestes. Il faudrait même établir des distinctions à l'intérieur de chaque groupe, car nous verrons que le cultivateur des Laurentides est moins riche que celui de la plaine, tout comme le papetier l'est moins que le tisserand. Les deux autres groupes, professionnels et propriétaires sont tous les deux plus indépendants de fortune; les premier vit d'honoraires et représente la classe instruite; les propriétaires sont les employeurs ou ceux qui travaillent à leur propre compte dans des entreprises commerciales, industrielles ou autres (non agricoles).

Economiquement, le diocèse a donc une fonction industrielle. Socialement, les fidèles forment en grande majorité un peuple de salariés. L'industrialisation a provoqué une prolétarisation (non au sens péjoratif) des diocésains.

Cherchons maintenant à quel groupe familial appartiennent les prêtres séculiers. Nous n'étudions que les séculiers non seulement pour des raisons statistiques, mais aussi parce qu'ils sont plus représentatis de la situation régionale que les réguliers nés en dehors du diocèse, et parce qu'ils sont davantage engagés dans le ministère paroissial.

Nous avons rattaché à nos quatre catégories précédentes les milieux d'enfance des 263 prêtres séculiers que le diocèse de Trois-Rivières avait en exercise en 1952. Ces milieux sont à la fois fonctionnels et sociaux; ils s'opposent bien entre eux et sont passablement homogènes. Le tableau III nous indique la prépondérance de la classe agricole; la proportion serait encore plus nette si l'on considérait uniquement les dignitaires qui donnent en quelque sorte le ton au clergé diocésain. Depuis les chanoines jusqu'à l'Ordinaire, la provenance agricole atteint un pourcentage de 50 pour cent; nous ne disons pas rurale mais agricole. Deux séculiers

TABLEAU III

Milieux d' origine des prêtres séculiers trifluviens, 1952 [1]

Classes Sociales		Pourcentage
I	Fils de cultivateurs	40
II	Fils de divers salariés	30
III	Fils de propriétaires industriels et commerciaux	20
IV	Fils de professionnels	9
	Total	100

[1] Panneton, Georges et Magnan, Antonio: Le diocèse de Trois-Rivières, Trois-Rivières, 1953, 381 pp.

sur cinq sont donc fils d' habitant, [1] dans le diocèse. Le grand nombre des prêtres de cette classe est en relation avec le fait que la plaine laurentienne a été jusqu' à la Première Guerre la première région en hommes du diocèse et qu' il y avait dans ce pays une certaine émulation entre les familles pour offrir le plus grand nombre de vocations. Il ne faut pas oublier que ces prêtres d' ascendance paysanne sont nés au cours de la période 1875-1925 et que durant la plus grande partie de cette époque, le genre de vie paysan était nettement prépondérant. Traditionnellement, les vocations étaient associées à la classe des cultivateurs non pas tant parce que ce groupe était relativement plus généreux que les autres, mais tout simplement à cause de sa prépondérance numérique. En nombre absolu, aucune classe n'en produisait autant. C' est elle qui fournissait le diocèse.

Continuons l' analyse des classes sociales du clergé avant de les comparer aux classes des fidèles. Le deuxième groupe en importance est constitué par les prêtres qui ont un père salarié dans divers domaines, mais nécessairement en dehors des groupes I et IV. Bien que ce groupe englobe un nombre très varié de travailleurs, 30 pour cent seulement de prêtres en sont issus. Puisque cette classe de fidèles a beaucoup augmenté en nombre au cours du XX^{e} siècle, il n' est pas possible de chercher son "coefficient de vocations sacerdotales". Nous sommes d' avis, cependant, que dans le passé, ce groupe n' a pas produit un pourcentage de prêtres équivalent à sa proportion numérique dans la société. Pour expliquer ce fait, il est logique de songer entre autres aux conditions financières difficiles, aux horizons intellectuels assez modestes ainsi qu' à l' habitude de cette classe d' alimenter de préférence les communautés plutôt que les séculiers. Ainsi moins d' un tiers du clergé séculier qui est actuellement en service dans le diocèse vient de la classe des salariés. Cette classe se situe, néanmoins, au deuxième rang dans notre classification.

Les prêtres des derniers groupes sociaux ont pour père soit un propriétaire industriel ou commercial, soit un professionnel. Trente pour cent des prêtres sont issus de ces deux corps qui sont loin de constituer dans la société une proportion aussi élevée. Nous sommes donc en présence de deux classes qui donnent plus de fils à l' Eglise que ne le laisseraient supposer leurs effectifs démographiques respectifs. Cela est logique car l' aisance pécuniaire des parents permet d' envoyer les

[1] Cultivateur: un peu différent du paysan européen.

enfants au séminaire dans une proportion plus considérable. Bien que les vocations soient relativement moins nombreuses chez les finissants issus des classes bourgeoises que chez ceux des classes populaires, la proportion des fils de propriétaires et de professionnels qui deviennent prêtres est plus forte que celle des enfants de cultivateurs et de salariés qui, eux, ne vont pas en assez grand nombre au séminaire. Pour être exact, il faudrait en outre distinguer la "production" en prêtres des propriétaires de celle des professionnels. Ceux-là semblent plus généreux.

La provenance sociale du clergé séculier nous permet de découvrir certaines caractéristiques qui ne le définissent, il va sans dire, qu'incomplètement. A quelques nuances près, ces étiquettes pourraient être appliquées à l'ensemble de nos prêtres. Ainsi ce clergé nous apparaît comme non aristocratique, puisque la majorité des clercs provient des classes situées au bas de l'échelle sociale: cultivateurs et salariés. Il est aussi sans grande tradition intellectuelle: seulement 10 pour cent des prêtres sont fils de professionnels; pour l'ensemble des prêtres, la culture classique sera quelque chose à apprendre en dehors du milieu familial; cela est pour eux et pour tous certainement un gros inconvénient de par la place que tient le prêtre dans l'enseignement secondaire. Ces séculiers ne sont pas non plus fils de riches, la plupart viennent de parents aux ressources limitées; étant données ces conditions financières le prêtre sera d'un côté épargnant et de l'autre, il ne dédaignera pas un certain confort, en compensation. Il sera enfin profondément terrien à cause de son ascendance soit purement paysanne soit simplement rurale. C'est ce clergé qui, dans l'ensemble de la Province, a été le témoin de l'industrialisation.

Prudence dans la comparaison

Il sera intéressant de comparer les tableaux II et III. Mais se comprennent-ils? D'un côté, nous avons les genres de vie pratiqués par les fidèles et de l'autre, les milieux familiaux des prêtres. Les deux termes ne sont donc pas équivalents et il serait plus rigoureux de mettre en parallèle les milieux familiaux des fidèles et ceux des prêtres. Nous trouverions que les fidèles et les clercs ont, en majorité, une même origine terrienne. Cette coincidence pourrait laisser supposer qu'aucun écart social ne puisse s'élever entre clercs et fidèles dans l'avenir. Or, à l'observation, nous constatons que malgré leur origine familiale identique, clerc et fidèles ne se comprennent pas facilement dans les villes. La comparaison que nous avons évitée n'avait donc que l'avantage d'être plus logique; elle était incapable de rendre compte de la distance sociologique entre les éléments du binôme paroissial. Il nous a paru alors plus utile de comparer les genres de vie des diocésains avec les milieux sociaux des prêtres; nous croyons même qu'il est plus exact de procéder ainsi car le fidèle est beaucoup plus influencé par le genre de vie qu'il pratique que par celui qu'il a connu durant son enfance; inversement, le prêtre que le sacerdoce retire en quelque sorte du monde est certainement poussé à incorporer les résultats de sa propre expérience de la vie matérielle - ses souvenirs d'enfance - dans l'image qu'il se fait du mode de vie de ses fidèles. Et s'il est disposé à ne pas se laisser influencer outre mesure par son milieu familial, il voit quand même le rythme de son adaptation ralenti à la fois par le mouvement généralement lent de l'Eglise dirigeante et par le fait qu'un prêtre ne peut vivre qu'indirectement le genre de vie de ses quailles.[1] Dans ces conditions, le préposé au ministère paroissial rejoint difficilement le fidèle

[1] S'il pouvait le vivre directement, il comprendrait mieux ces derniers; probablement que nos "curés" n'ont jamais été plus du peuple que lorsqu'ils cultivaient les "Terres de Fabrique". En général, les prêtres n'ont pas à exercer le métier de leurs fidèles.

sur le plan sociologique.[1] Cet écart, même lorsqu'il est atténué par un double effort de rapprochement de la part des clercs et des fidèles, traduit toujours la distance fondamentale qui peut s'établir entre un fidèle qui pratique tel genre de vie et un clerc qui en a vécu un autre durant son enfance. Il nous semble donc permis de comparer les milieux d'origine des séculiers et les champs d'activité des fidèles.

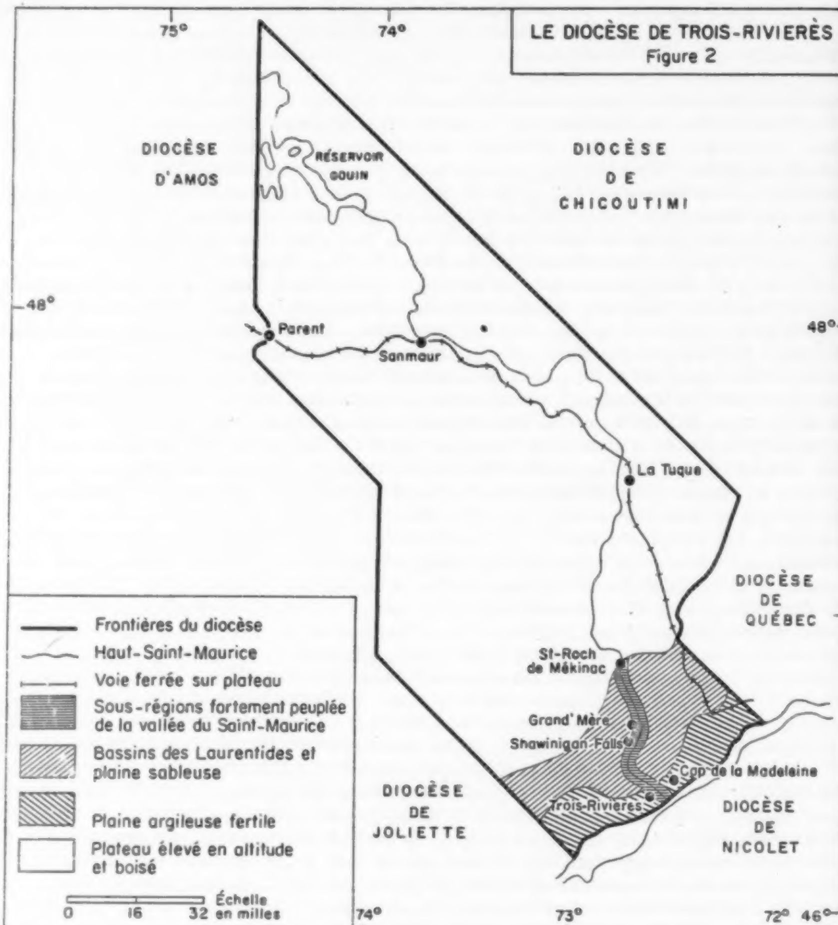
Il ne faudra pas demander un ajustement mathématique de part et d'autre. Un prêtre, fils de professionnel, peut bien réussir auprès de fidèles prolétaires. Mais, à priori, un prêtre fils d'habitant a plus de chance de comprendre les réactions de paroissiens cultivateurs qu'un curé très cultivé et bourgeois. Même si nous pouvons trouver des exceptions, un prêtre doit avoir plus de facilité pour exercer son ministère auprès de fidèles de même niveau et de même région qu'auprès de groupes étrangers. L'établissement souhaitable d'un clergé indigène dans les pays de mission n'est qu'un élargissement de ce principe. Le prêtre comme tout individu reflète son milieu social d'origine, surtout celui de son enfance. Ainsi, l'on a dit du clergé français qu'il est à l'image de la classe moyenne, dévoué, patient, exact, mais manquant peut-être un peu d'ardeur missionnaire et aussi de la passion de la justice sociale.[2] Ce jugement n'est plus vrai aujourd'hui au moins pour les clercs progressifs. Quoique nos pays et nos classes sociales aient sur les gens une empreinte plus faible que celle qu'exercent les régions et les groupes européens, il n'est pas faux de s'attendre à trouver dans les attitudes des prêtres des traces de leur milieu. Nous ne voulons pas dire que celles-ci sont nécessairement prédominantes. En effet, le prêtre au cours de ses études, de ses contacts et de ses voyages peut revêtir des attitudes qui ne sont plus celles de sa jeunesse. Il est évident que le prêtre, tel un humaniste, est formé par une foule de facteurs qui peuvent même à la longue reléguer ses habitudes sociales originelles à un rang tout à fait secondaire. Mais, cette universalisation des horizons n'est pas le propre de chacun. Beaucoup de prêtres, souvent absorbés par un travail exténuant n'ont pas le temps d'entreprendre des études spéciales pour s'ajuster au milieu où ils auront à se dévouer. Combien de prêtres engagés dans le ministère ou dans l'enseignement, poursuivent des études spéciales en sociologie ou en pédagogie? Ils sont parfois les premiers à souhaiter ces études, mais leur présence étant requise sur le champ, ils sont obligés de se mettre à la besogne avant de réaliser leur légitime ambition. D'autres prêtre n'ont pas la chance de changer de milieu social: nous pensons ici en particulier à ces enfants qui naissent dans certaines petites villes de la Province et qui successivement font leur classique dans l'institution locale, vont au Grand Séminaire dans le même milieu, sont ordonnés dans l'église paroissiale et passent leur vie au même endroit. Dans ces conditions, le milieu d'origine a de multiples chances de laisser sa marque. En tous cas, il en laisse certainement une chez les prêtres qui croient que l'ordination leur a conféré absolument toutes les qualités nécessaires pour réussir dans tous les domaines; ils n'ont pas besoin alors de se préoccuper du problème de l'ajustement social. Bref, l'influence du milieu est indéniable et les Ordinaires en tiennent compte avant de faire les nominations. Le prêtre est donc influencé par son milieu d'origine et il est préférable que fidèles et clercs, sur le plan paroisse sinon sur le plan individu, composent un ensemble plutôt homogène, du moins une communauté.

Il ne faudrait pas conclure automatiquement à l'inefficacité du ministère si la comparaison sociologique clercs-fidèles révèle un écart sérieux mais au moins à la pratique pastorale plus difficile.

---

[1] Evidemment qu'il peut se trouver des exceptions.

[2] Alfred Rambaud, d'après le chanoine Fernand Boulard: Où en est le clergé français?, dans La Revue de l'Université Laval, vol. 7 (1952) no. 4, déc., p. 315-323.



LE DIOCÈSE DE TROIS-RIVIERÈS
Figure 2

Le diocèse s' étend sur les cinq comtés de Maskinonge, de Saint-Maurice, de Laviolette, de Champlain et de Trois-Rivières. Il touche aux quatre régions géographiques de la plaine laurentienne, des Laurentides, du plateau mauricien et de la vallée du Saint-Maurice. Un dizième seulement du diocèse est habité. La majorité des catholiques sont groupés dans la partie la plus avantagée du Sud. Le reste est échelonné le long du Saint-Maurice ou le long de la voie ferrée lorsque celle-ci s' écarte de la vallée. A l' intérieur de la partie méridionale habitée, c' est sur le Bas-Saint-Maurice, en particulier à Trois-Rivières, à Shawinigan, à Grand' Mère et au Cap-de-la-Madeleine que s' est fixée la population. Il faut voir si le cadre paroissial et la classe des clercs sont adaptés à cette géographie.

Comparaison

Maintenant que nous avons présenté les membres du clergé séculier qui à l'encontre des réguliers naissent et vivent dans le diocèse, comparons les classes sociales des prêtres et des fidèles. La proportion des prêtres-fils d'habitants est beaucoup plus forte que celle des fidèles-cultivateurs. Les deux-tiers des prêtres de cette catégorie doivent alors s'occuper de fidèles qui ne sont pas de leur classe sociale; le surplus des prêtres issus de la terre doivent faire leur ministère auprès d'ouvriers, de professionnels et de riches propriétaires. L'écart pourrait être sociologiquement grand si ce n'était de l'origine terrienne des fidèles de ces trois dernières catégories; après leur installation en ville, les émigrés de la campagne réagissent encore parfois en ruraux et en cultivateurs; durant ces moments l'amplitude sociale qui les sépare de leur curé, né à la campagne dans une ferme, est réduite. Mais si l'on excepte ces périodes de plus en plus espacées au fur et à mesure que le rural devient urbain, il reste que le clergé est plus terrien que les fidèles.

Inversement, il est beaucoup moins ouvrier qu'eux. Le peuple est salarié de l'industrie et du commerce dans une proportion de 75 pour cent tandis que le prêtre est issu de cette classe dans 30 pour cent des cas. C'est ici que le déséquilibre est le plus accusé. Ce sont des prêtres appartenant aux trois autres classes qui sont obligés et dans une très forte proportion de remplacer les prêtres qui manquent auprès des ouvriers.

Par suite de la grande stabilité des deux autres groupes de fidèles, propriétaires et professionnels, et par suite de leur forte contribution aux vocations sacerdotales, ces classes sont amplement pourvues de prêtres de leur milieu. Donc, pour ces classes, le problème de l'homogénéité clercs-fidèles est beaucoup moins aigu. Malheureusement, d'une part, ces groupes sociaux sont loin de représenter la majorité des fidèles (13 pour cent), et, d'autre part, ils ne sont pas groupés à l'intérieur de paroisses "sociologiques".

Ainsi, d'une façon générale, apparaît une certaine inadaptation sur le plan social entre les fidèles et les clerc à l'intérieur du diocèse de Trois-Rivières. Pour résumer statistiquement la situation, disons que tout prêtre a sept chances sur dix de rencontrer un salarié lorsqu'il est devant un fidèle. Tout fidèle n'a pas une chance sur trois de rencontrer un prêtre fils de salarié. Un salarié n'a pas une chance sur deux de rencontrer un prêtre de sa classe sociale. Bref, à peine dans la moitié des cas, prêtre et fidèle de toute classe sont du même milieu.

Conclusion

Ainsi isolé, un tel cas d'inadaptation exige d'être interprété avec prudence. Aussi ne voulons-nous pas disserter ni sur les responsables de la situation ni sur les conséquences qu'elle entraîne dans les domaines de la politique de l'Eglise, de l'efficacité du ministère et de la vitalité religieuse populaire. Nous attendrons d'exposer d'autres aspects de l'écologie diocésaine avant d'esquisser une opinion.

Pour terminer, nous voudrions simplement envisager l'avenir de l'inadaptation sociale dont nous avons parlé. L'écart va-t-il, oui ou non, s'accentuer? Le clergé va-t-il rester rural? Les fidèles urbains qui ne se suffisent pas en prêtres vont-ils accroître leur "coefficient sacerdotal"? Dans le passé, les cultivateurs composaient la classe la plus forte dans la population totale et assuraient le recrutement du clergé diocésain; maintenant que nous assistons à l'effacement de ce groupe au sein de la communauté, quelle autre classe va-t-elle la remplacer comme "productrice" de prêtres?

Pour voir clair, retournons de nouveau aux statistiques.

Les jeunes prêtres sortent des mêmes milieux que leurs ainés mais la contribution respective de chacun des niveaux sociaux a profondément changé.

TABLEAU IV

Milieux sociaux d'origine des "vieux" et des jeunes prêtres, diocèse de Trois-Rivières, en pourcentage[1]

Catégories	Prêtres Nés Avant 1915	Nés Après 1915
Fils de cultivateurs	48%	25%
Fils de salariés	25%	40%
Fils de commerçants et d'industriels	19%	25%
Fils de professionnels	8%	10%
Total	100%	100%

[1] Panneton, op. cit.

Le clergé devient moins paysan, la proportion descend presque de moitié (de 48 pour cent à 25 pour cent). Il est probable que le pourcentage des prêtres fils d'habitants s'établira à 15 pour cent de l'ensemble, environ.

Le clergé devient beaucoup plus ouvrier; la proportion s'élèva à 40 pour cent. Nous croyons voir dans la classe ouvrière la relève du groups paysan. Les salariés profitent de la proximité des collèges pour y envoyer leurs fils et augmentent ainsi leurs chances d'avoir des prêtres. Nous ne sommes pas surs cependant que le taux des finissants fils d'ouvriers qui choisissent le sacerdoc équivale à celui des finissants fils de cultivateurs. Cependant, actuellement, le jeune clergé n'est pas encore assez ouvrier, étant donnée la composition sociale de la population.

A l'image de l'ancien clergé, le groupe des jeunes séculiers continue d'être articulé à l'ensemble des classes sociales de la société dans ce sens que chacune d'entre elles produit des clercs, mais il n'y a cependant pas articulation vraie puisque la proportion de chacune des classes des clercs à l'ensemble de la population n'est pas respectée: les propriétaires et les "professionnels" donnent relativement plus de prêtres que les salariés et les cultivateurs. La profession du père garde donc son importance pour expliquer le recrutement. Le "coefficient sacerdotal" de chacune des classes n'est pas fonction de l'importance numérique de la classe.

Nous constatons aussi une ascendance sociale générale. Les groupes III et IV qui peuvent être considérés d'une certaine façon comme les groupes "bourgeois" fournissent de plus en plus de candidats à l'évêché, proportionnellement au nombre total des aspirants.

Le rythme de l'évolution de la contribution de chaque classe sociale à la composition du clergé séculier, s'il pose des problèmes, tend néanmoins à créer un certain équilibre dans la composition sociale des clercs. Du moins, nous pouvons affirmer que nous nous éloignons d'une distribution caractérisée par la prépondérance nette d'une classe, comme c'était le cas à la fin du XIX[e] siècle.

Le jeune clergé est aussi moins rural que ne l'était son prédécesseur; et il le sera de moins en moins avec les progres de l'urbanisation.

Les jeunes clercs montrent donc des caractéristiques sociales différentes des vieux prêtres. Il découle de cette nouvelle constatation des conséquences majeures. En voici quelques-unes. D'abord, le jeune clergé semble mieux adapté à la situation actuelle que le "vieux" clergé. Nous ajoutons en plus de ce que nous avons

déjà dit que le "vieux" clergé est né avant la phase de l'industrialisation massive provoquée par la première grande guerre; de plus l'âge moyen de ces prêtres ainés fixé à 55 ans leur rend certainement difficile la pratique du ministère auprès d'une population diocésaine très jeune (54 pour cent des habitants ont moins de 25 ans). Les jeunes clercs sont plus près de la population, biologiquement et socialement. Leur collaboration pourrait être encore plus précieuse s'ils étaient plus nombreux et surtout, s'ils étaient chargés de pouvoirs.

La distance sociale qui sépare les "vieux" des jeunes clercs a créé inévitablement une certaine coupure à l'intérieur du groupe des séculiers. Cette fissure est discrète, inavouée, mais elle est visible en divers domaines.

L'industrialisation de la Mauricie a donc provoqué de profonds changements sociaux à l'intérieur du diocèse de Trois-Rivières. Par son jeune âge et sa prodigieuse rapidité la révolution économique régionale a créé un peuple urbain et ouvrier avant que le clergé n'ait eu le temps de se renouveler. Le déséquilibre actuel tient partiellement au fait que nous sommes encore dans cette ère de transition dont la fin pourrait nous conduire vers 1970. Nous serons alors définitivement dans le second diocèse de Trois-Rivières.[1]

---

[1] Les lecteurs qui désireraient des indications bibliographiques concernant la sociologie religieuse, et des données statistiques complémentaires se rapportant au diocèse de Trois-Rivières pourraient consulter le texte suivant qui a été préparé par les auteurs de cet article: Quelques matériaux destinés aux chercheurs en sociologie religieuse canadienne, 50 pages, (à paraître bientôt).

THE PROBLEM OF GEOGRAPHICAL REGIONS IN CANADA

J. Lewis Robinson

University of British Columbia

A great deal has been said in our geographical literature about the problem of geographical regions. In opening this panel discussion, it is my purpose to deal briefly with the philosophy of regions, and to suggest some regions for the study of the geography of Canada. Most geographers agree that the analysis and interpretation of regions are one of the fundamental cores of geography, but despite this general agreement, we have much difficulty in defining a "geographical region". It is doubtful if we have answered the question for non-geographers by stating that it is the character of the "core" of the region that is important and not the exact outer limits of the region. We state that the boundaries of geographical regions are transitional zones that denote that the combination of geographical characteristics of the area on one side of the line is different from that on the other side. Although we can solve this vexing problem academically by calling upon the "transition zone", it still remains difficult to place this zone as a line upon a map. It may be still more difficult to teach this concept of geographical regions in our schools, when we insist on the geographical region as a tool to studying the nature of a country, and yet cannot definitely define our regions.

If geographers have had difficulty in defining a geographical region as a statement of our philosophy, it is therefore not surprising that we should have further difficulty in attempting to define the geographical regions of Canada. If this difficulty is causing confusion and uncertainty in the minds of many Canadian teachers, it may cause an unfavourable reaction to geography in general. There must be some who say, "If you state that regions are the core of geography, and then cannot define your regions, there must be something wrong with your philosophy of geography". Geographers who understand the development of geographical philosophy over the past century, probably are satisfied with our definitions because we recognize their limitations and their function. We know that it is the regional concept that is more important than the definitions. There may be many school teachers, however, whose task it is to teach the geographical character of regions of the world, who have less confidence in our philosophy.

Geographers believe that the character and size of a region are partially recognized by the purpose for which it is being studied. From a teacher's point of view, geographical regions are a tool to show the similarities and differences from place to place throughout the world. The size of the geographical region is a very practical problem, which is greatly determined by the length of the school term, and the total area of the world to be studied. A study of Ontario in a full year would permit the detailed analysis of the province by means of 20 or 30 geographical regions, which would show the differences which we know exist. However, in a study of Canada, or of Anglo-America, the time devoted to Ontario must be less; this requires more generalization, and the differences and similarities might have to be condensed into three or four regions. Further, on a world scale, the time devoted to Ontario has to be indeed short, if the student is to know something of the character of the rest of the world, and Ontario might have to be studied as but a <u>part</u> of one or two larger regions. As illustrated in this example, geographers have agreed that there is a hierarchy of regions, which are defined by the purpose of the study, the amount of time available and the detail required.

The practical problem, therefore, of what are the geographical regions of Canada, must first be prefaced by a statement of the purpose of such regions. This

concept that geographical regions, which are supposed to have definite character and a notable degree of homogeneity, vary, dependent on the purpose, must indeed be difficult for non-geographers to understand! But if the regional concept is fundamental to the understanding of the philosophy of geography, it is part of the "public relations" that we must undertake among those who do not fully understand the nature of geography. We must explain that geographers do understand that there will be different geographical regions of Canada, depending upon the time devoted to a study of the geographical nature of Canada.

Our problem is more serious, however, when we have decided that our purpose is, for example, a study of the geography of Canada in a full school year, and then still cannot define or agree upon our regions. Perhaps it is an indication of the youthfulness of modern Canadian geography, and geographers, that this problem has not been tackled before. It is certainly worthy of research and analysis, followed by discussion, and I should hope, some general agreement among Canadian geographers.

Suppose we state that our purpose is to know the geography of Canada at high school level, and by that we mean to understand the similarities and differences that exist from place to place in Canada. One of our tools of study is the geographical region which describes and explains the character and interactions among the physical, human and economic phenomena of the region. The size of the region is influenced by the amount of time that the class has available to study the detail of each region. In order to see the broad character of Canada in general at school level, I believe there should be as few regions as is possible.

To me, one of the fundamental influences that causes differences from place to place in Canada, is the landform character of our physiographic regions. This is not to say that other factors, such as climate or culture have not played a part in causing differences, but only to say that landforms play a major part, and are a proper place to start. For example, there is major difference in the physical appearance, economy and general "way of life" between the Canadian Shield region and the St. Lawrence Lowlands. In another case, it may be agreed that there are similarities in the economy and pattern of settlement between the hilly Maritimes and rugged British Columbia, but that the differences can be greatly attributed to the different scale of relief. Lest I be misunderstood or misquoted, let it be clear that the above statements do not say that the character of the landform regions causes or "determines" the differences. I, and most other geographers, take for granted that we understand that the character of regions is the result of the interaction of many factors, which vary in emphasis from place to place. I am saying, however, that these differences (which have a variety of causes) are most apparent in the landform, or physiographic regions of Canada, and that they are the best tool to use to learn something about the geography of Canada.

I therefore propose that a study of the regional geography of Canada should start with the physiographic regions. In the far east there is the Appalachian-Acadian system, which includes Newfoundland Island. It seems to me that the fishing and forestry economy, and the linear or spotty pattern of settlement can be greatly attributed to the type of landforms. The rolling, hilly to rocky lands of the Appalachian system have placed their stamp upon the character of the economy and the settlement patterns of the Atlantic provinces. Agriculture is in the narrow valleys and lowlands, forestry dominates in the uplands, and fishing is aided by the indented, abrupt coasts.

The St. Lawrence Lowlands are the largest extent of level land with favourable climate in Canada. The dense pattern of settlement, based on a solid foundation of agriculture, can be attributed in no small measure to the advantages of level to rolling land. The fact that the lowland opened out to the broad estuary of the St. Lawrence River was important in its early history and start of settlement.

The rocky, knobby lake-covered surface of the Canadian Shield has a different type of landform than the hilly Appalachians, but at the same time there are simila-

rities in the type of economy (although not in the manner or intensity). It is quite apparent that the combination of physical conditions in the Shield has given a geographic character which is distinct from that of the St. Lawrence Lowlands. For example, the fact that there is very little outward difference in appearance between the Lake St. John Lowlands and the Quebec Lowland (despite their separation in location) emphasizes that landforms cause the major difference in character between the Shield and Lowlands. In the northern part of the Shield, however, the influence of the Arctic climate has a greater dominance than landforms, and I believe that the treeless area of the Shield should be attached to the Arctic region.

The level lands of the Interior Plains have many similarities to the landscapes of the St. Lawrence Lowlands. Many of the differences can be attributed mainly to the different length of period of settlement. That southern Manitoba, being closest to the historical source of settlers in Ontario, is gradually taking on many of the characteristics of southern Ontario, emphasizes that these plains may have greater similarities in the future. There is no doubt but that there is a great deal of diversity in the Plains region and a region of such a large size should not be expected, to have the homogeneity demanded of some geographic regions. However, if we are to keep our regions few in number, for teaching purposes, the Plains region can be used to show how the area is different in many ways from the adjoining Shield and Cordillera.

There can be little doubt but that the geographic character of British Columbia and Yukon is dominated by mountains. There is much about British Columbia that is similar to other parts of Canada - for example, the linear fruit valley of the Okanagan is not unlike the Annapolis Valley of hilly Nova Scotia; the pioneer farms of central British Columbia look no different than pioneer farms in northern Saskatchewan. However, the essential character of the province comes from the mountains which separate and channel activities. The variety of geographical characteristics which result from a variety of slopes and climates means that there is no homogeneity in British Columbia except in very small areas. The one thing that is common to virtually all of British Columbia and Yukon, and which is different from the rest of Canada, is its mountainous environment.

The Arctic region is the only part of Canada which is distinct, due more to its climate than to its landforms. The island character of the region, which is different from the rest of Canada, however, has given the region problems of accessibility and ice conditions which are unique.

I realize that there is valid criticism to breaking the Canadian Shield region by a climatic line, and some will object that the Arctic Islands, with their variety of physiographic character, are not a physiographic region. These facts I recognize, but I believe that the character of the geography of Canada will be better understood by making these changes. Note that I said that for teaching purposes the geographic regions of Canada can be <u>based on</u> the physiographic regions, <u>not are</u> the physiographic regions.

If these regions are properly described, and analysed to show the interactions among physical, economic and human phenomena, the student will understand a great deal about the differences that exist from place to place in Canada. We will agree that the student may still not know and understand Canada in detail. Each of these six regions is large, and there is by no means complete uniformity within any one of them. If there is sufficient time available, or if more time is allotted because of the value obtained, it would be most useful to study further subregions. These subregions would illustrate the principle of hierarchy of regions, and would give greater detail to the complexity that is found within each physiographic division. For example, perhaps the Canadian Shield could be subdivided into a "Southern Fringe" which would include the penetration valleys of the Saguenay, St. Maurice and Ottawa, and the central area of the Great Clay Belt; and an "Extractive Belt", which would include the

relatively small forestry and mining centres extending from southern Labrador to the shores of Great Bear Lake. Such subregions which are based greatly on the character and amount of settlement may change over the years, and may be objectionable to those who believe that a geographical region should be a more permanent thing.

In like fashion, the Interior Plains could have subregions consisting of the "Agricultural Zone", the "Pioneer Fringe", and the "Northern Forest", the latter including the large area of the Mackenzie Valley. Again the criticism of basing subregions upon the character of economy, which may change, is valid. I feel, however, that the physical geography which has so greatly influenced the character of Canadian economic patterns, is permanent enough that these established economic activities will change only in intensity rather than type.

It is not my purpose to state at this time how many and where are the subregions of Canada. I am sure that many will say that the subregions should be raised to the status of full regions. The greater the number of regions, the more detailed knowledge the student has, but there is also the danger that too many regions will detract from the total picture of understanding Canada. Within our time limitations, we should strive for that "medium" number of regions and subregions which permits the student to understand the general picture of Canada's geography, and still be familiar with regional differences, which the regional approach presents. As stated earlier, I believe that the six regions outlined here, based on physiographic divisions, show the similarities and differences in Canada that can be taught in a one-year course.

I would propose that this important problem of geographical regions of Canada is a worthy study for the Canadian Association of Geographers. Collectively, and by agreement, the Association should be able to prepare a map of geographical regions and subregions of Canada. Such a map would be one which this body of geographers would be prepared to defend and to publicize, as our concept of the Geographical Regions of Canada for the purposes which will be stated. Since geographers have never agreed upon the definition of a geographical region, it should not be expected that we would agree upon the extent of the geographical regions of Canada. However, all of us should know the geography of Canada well enough to agree that there are regions. If we can decide upon the desirable number (which will determine the size of each region), and the purpose of a regional breakdown, perhaps we can decide, with surprising agreement, upon the regions themselves.

THE CANADIAN ASSOCIATION OF GEOGRAPHERS

THE CANADIAN COMMITTEE OF THE INTERNATIONAL GEOGRAPHICAL UNION

The name of Professor L. E. Hamelin (Université Laval) was inadvertently omitted from the membership list of this committee, as it appeared in The Canadian Geographer, No. 5. Since the list was published there has been one change - Mr. Max H. Wershof replaces Dr. R. A. MacKay, who has gone to United Nations headquarters in New York.

Plans are being made for Canadian participation in the Eighteenth International Geographical Congress to be held in Rio de Janeiro from August 9th to August 18th, 1956. According to preliminary information, ten Canadians hope to present papers.

UNIVERSITY NEWS

Alberta

Geography instruction at this university was expanded in the fall of 1955 with the appointment of A.H. Laycock, B.A. (Tor.), M.A. (Minn.), as Lecturer in Geography. For the past two years he has been employed in hydrology research with the Eastern Rockies Forest Conservation Board. At present he is continuing with his research for publication and completing his Ph.D. thesis for the University of Minnesota.

As of the fall of 1955, students may work towards the degree of B.A. or B.Sc. in geography for the first time.

Dr. William C. Wonders continues his research into the urban geography of Edmonton and the settlement and development problems of the northern parts of the province. During the spring he participated in a regional planning conference in the Peace River area and returned in the fall, at which time he also visited Hay River, N.W.T.

British Columbia

Last summer the Geography Department had the largest group of geography teachers in Canada (230) taking four summer courses. This year undergraduate enrolment totals 770 in 12 full-year courses. There are eight graduate students working for advanced degrees in geography.

One of the main projects in which the department is interested is the preparation of an "Atlas of British Columbia Natural Resources". The Atlas is under the general editorship of Professor John D. Chapman, and Professor Richard Ruggles is one of the two cartographers. The other cartographer is Mr. Albert Farley, geographer for the British Columbia Department of Lands. The Atlas will have 92 maps and will make full use of colour. Its overall dimensions are 17 x 21 inches. There are three sections: Part I - Physical and Human Geography - 21 pages; Part II - Resource Use - 21 pages; and Part III - Map Indices - 4 pages. Each map is accompanied by an illustrated text on the opposing page. The individual maps were compiled by specialists mainly from the University of British Columbia and British Columbia Government Services. Drafting has been done by University of British Columbia graduate geography students. The Atlas, which was planned in January, 1954, is sponsored by the British Columbia Natural Resources Conference, and publication is expected by about April, 1956.

Dr. J. Ross Mackay has been engaged in writing up the results of three field seasons' work in the Western Arctic area between the Mackenzie River delta and Darnley Bay. He also has research in progress in defining the effects of the Canada-United States boundary in terms of geographical distance for various types of social interactions.

Carleton College

A course in "The Geography of Canada" is being offered during 1954-55 in the Evening Division in addition to a reading course for selected students on "Elements of Geography".

Laval

Le succes des Cours d'été de géographie qui ont été suivis par 55 studiants.

La fondation d'un Institut de Géographie, autonorne et séparé de l'Institut d'histoire. M. le docteur Louis-Edmond Hamelin en est le directeur et M. Fernand Grenier en est la secrétaire.

L'Institut de géographie a deux nouveaux professeurs M. Max Derruau, Docteur es Lettres, professeur français qui est invité à Laval pour trois mois. M. Fernand Grenier a commencé à enseigner le géographie en septembre 1955 a l'Institut de Géographie.

Les Cahiers de Géographie ont publié leur sixième numero: Pierre Biays. Conditions et genres de vie au Labrador septentrionnal.

Une visite entre les etudiants et les professeurs des départments de Géographie des Universités de Toronto et de Laval est projetée en novembre 1955.

Manitoba

The Department of Geography continues to teach a large undergraduate enrolment of 250 students as well as offering graduate work to a few. Two theses are in process of writing: A Geographic Analysis of the Sugar Beet Industry in Manitoba, and The Historical Geography of Greater Winnipeg City.

Dr. Weir is preparing a series of economic maps which it is hoped will eventually be bound in Atlas form on the Canadian Prairie Region. Professor Watts is continuing his study on A Precise Climatic Definition of the Vegetation Zones of the Southern Great Plains of Canada.

The Manitoba Geographical Society, of which Dr. Weir is chairman, continues to have monthly meetings during the winter and a spring field trip. Membership is 120.

Dean N.V. Scarfe of the Faculty of Education is chairman of the I.G.U. Commission on the Teaching of Geography. In this connection he visited Europe this summer to confer with Dr. G.M. Hichman of Bristol, Dr. C.A. Alagoz of Ankara, and Dr. L. Dudley Stamp. He is preparing the report to be presented at the I.G.U. congress in Rio de Janeiro in August, 1956.

At the National Council of Geography Teachers' 41st Annual Conference in Indianapolis on November 25, 1955, Dean Scarfe was Banquet Speaker. His topic was "Geographic Education and Teaching Method". At this meeting he was awarded the George J. Miller prize for an article in the Journal of Geography "which has been of most value to the largest number of teachers during the last five years". The article was "Testing Geographical Interest by a Visual Method". He was also the author of Modern Geography which was published by W.J. Gage and Company, Toronto.

McGill

Gordon Merrill was appointed Assistant Professor in 1955.

Research in geography at McGill University is orientated toward the Arctic. The McGill Sub-Arctic Research Laboratory, located at Schefferville on the Labrador plateau, began operations in the summer of 1954. The laboratory operates a weather station for the Department of Transport of Canada, and the facilities of the laboratory are being used by various scientific departments of the government and universities. A research program of broad scope in Arctic meteorology was started on the McGill campus in 1954, and is continuing. Several members of staff are engaged in accessibility studies of Arctic regions. These research activities permit the department to

offer a number of fellowships and assistantships to qualified candidates regardless of nationality.

McGill and the University of Montreal are joint hosts to the Association of American Geographers for its fifty-second annual meeting to be held in Montreal from April 2nd to April 5th.

McMaster

The Department of Geography has recently moved to new quarters with more space and better equipment. The accommodation includes a lecture room, a cartography room with 24 drafting tables, a map library, a seminar room, a graduate research room, a photographic dark room and four offices.

W.H. Parker lectured at Oxford University for the Trinity Term and while in England continued his research in the Historical Geography of Canada, 1837-1867. H.R. Thompson has completed a series of papers on the Geomorphology and Climate of the Pagnirtung Pass Area of Baffin Island. H.A. Wood attended the meetings of the Pan-American Institute of Geography and History at Mexico City and presented a report on the teaching of Geography in Canada. L.G. Reeds has been appointed Vice-Chairman of the local regional planning board.

Montreal

Camille Laverdière, assistant professor, has led a second expedition in the Northeastern part of the Abitibi-East County during the summer 1955. He travelled 750 miles by canoe surveying the territory. Professor Robert Garry has been doing research in Ottawa and Toronto for the preparation of a study on Geography and Aviation. Dr. Henri Enjalbert, professor at the University of Bordeaux, France, is the visiting professor of the Department of Geography of the University of Montreal for 1955.

Camille Laverdière has been appointed assistant professor in order to replace Marcel Bélanger who is travelling in Europe at present.

Ottawa

Mr. Uuno Helava has been appointed as lecturer in Cartography. Also, the Department has organized two graduate courses, namely, Geography of Anglo-America and History of Geographical Discoveries and Travels. During this calendar year, Prof. Jost published "The First Russian in India, an outline of Nikitin's Diary" in *Revue Canadienne de Géographie*, Vol. IX, N. L. January-March 1955, and "Les territoires récupérés de la Pologne" in *Revue de l'Université d'Ottawa*, Vol. 25, No. 4, Oct.-Dec. 1955.

Toronto

Dr. D.F. Putnam taught at the Nova Scotia Summer School, Halifax, in the summer of 1955. He is completing the manuscript of a Geography of Canada in collaboration with Dr. Kerr for the high schools. Dr. George Tatham conducted classes in Geography for the Army at Kingston, Ontario, in the summer of 1955. Is continuing research on the History of Geographic Thought. Dr. Donald Kerr lectured at the University of British Columbia summer school of 1955. Is continuing research on the Geography of Manufacturing Industries in Canada. Dr. Jacob Spelt obtained a Ph.D. from the University of Utrecht in the spring of 1955. His book, *The Urban Development of South Central Ontario*, has been published by Van Gorcum, Assen, The Netherlands. He is continuing research on Urban Geography. Dr. J. Howard Richards is engaged in research on urban land use for the Toronto Metropolitan Planning Board. Mr. Ali Tayyeb has completed his doctoral dissertation on the Geography of Pakistan. Mr. George Potvin was engaged in research on urban land use for the Toronto Metropolitan Planning Board in the summer of 1955. Mr. John Crosby is working on several different projects in cartography.

Western Ontario

Enrolment in undergraduate courses and graduate studies remains at a high level. More than 40 geography teachers are working towards the Type A Specialist in Geography at the University of Western Ontario. The alternate agreement enables the in-service teacher to complete the specialist course in geography through extension, correspondence, and summer school work. The technical and practical courses are given at summer school. This program takes the average teacher about five years to complete. Requirements for entering the "alternate program": a degree from a university, the type B teaching certificate (gained by a year's post-graduate work at Ontario College of Education) and an actual appointment teaching geography in a secondary school.

During the summer of 1955, Prof. Packer taught at the University of British Columbia and Prof. Langtvet at the University of Oslo, Norway.

The department sponsored the first Canadian civil defence seminar for teachers (July 1955); the first Canadian traffic training and planning course (May 1955); and the first Ontario water resources conference (November 1955). It is also working on several research projects concerned with geographical problems in the region which the university serves.

GEOGRAPHICAL BRANCH, OTTAWA

During the summer of 1955, field work was undertaken as follows (party leaders' names are underlined):-

Southern Saskatchewan: M.H. Matheson; R. Drinnan
Newfoundland: C.N. Forward; R. Officer
Quebec City urban analysis: P. Camu; L. Hamelin; J.A.P. Bussière; L. Michaud; L. Trottier; P.A. Lamoureux.
Toronto urban analysis: L. Prior; D. Armstrong; C. Fors; J. Kajioka; J.G. Reid.
Winnipeg urban analysis: T. Weir; J. Friesen; J. Warkentin
Mackenzie delta: J.R. Mackay; J.K. Stathers.
Cambridge Bay: J.K. Fraser; H. Frebold.
Eureka: V. Sim; M. Marsden.
Mould Bay: B. Robitaille; L. Hudon.

J.K. Fraser and J.K. Stager are on educational leave at Clark University and the University of Edinburgh respectively. George Bevan has now returned from seconded duty with the International Supervisory Commission in Indo-China. Len Prior has resigned to take up an appointment with the Toronto Metropolitan Planning Board. Muriel O'Shea resigned to become Len's wife! After a summer in the Arctic, L. Hudon transferred to the Public Archives of Canada. Murray Dobson was transferred to the Civil Service Commission and Stella Bonk has returned to teaching. Gerry Fremlin and Dr. M. Sebor joined the Branch from the Universities of Western Ontario and McGill respectively.

The Branch published Memoir No.3 (Geographical Discovery and Exploration in the Queen Elizabeth Islands, by Andrew Taylor); Memoir No.4 (Ranching in the Interior Plateau of British Columbia, by T.R. Weir); four reports in Geographical Bulletin No.7 and two bibliographies. In addition, some five articles were published by Branch members in professional journals.